Silcopac D

Hardware & Software Manual



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SILCOPAC D

HARDWARE AND SOFTWARE MANUAL

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Revision:	0.**3**
SW Version:	2.7 E
Date:	**Nov-07**

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Answer Drives S.r.l. . thanks you for choosing a product of the SILCOPAC family and for any useful advice aimed at the improvement of this manual.

SPDM New FIRMWARE 2.7

Preliminary remarks

Today, the standard firmware installed in the SPDM is the 2.6 enhanced version with Profibus-DP protocol inside (the Profibus DP board is delivered as option kit "SPPB2").

This firmware doesn't support the PC tool program "WZSPD", than we cannot have PC tool and Profibus-DP communication at the same time in one control board.

The "Centronic" printers today are not available in the market, so it's not possible to print the following data:

DRIVE TRACE
THYRISTOR TRACE
CONFIGURATION PARAMETERS

To remove the above problems we have developed the new release 2.7.

New 2.7 firmware release allows:

A) PC Tool and Profibus-DP communication at the same time.
B) Data print (by PC).
C) New functions.

New functions:

1. Emergency ramp. It will be possible to define a ramp with settable time on the emergency stop (TH3=TacRF, TH4=TdcRF).
2. "Bump less" function. It's possible to restart a motor runnig with the same reference of the actual speed (only with the ramp enable). In the previous releases the speed reference started from zero: this generated dangerous hard braking torque for 4-quadrant operation SPDM.
3. Speed reference adding term: now it can be added downstream ramp also (CFA=NoADVR=ON/OFF).
4. Torque proof: the user can manage completely the mechanical brake with a digital output (D01÷D07).
5. Disabling of the regenerative braking: the user can disable the regenerative braking when the armature voltage level becomes greater than a programmable threshold.
   CEC = Dis Reg = ON/OFF
   CE2 = Armature voltage threshold level.
   This function is helpful to avoid burning of fuses, when is not possible to maintain the right margin between the power supply voltage and the armature voltage level (for example with low Rsc ratio, or net with negative voltage variations greater than 10%).
6. Speed visualisation: the user can configure one of the auxiliary variable *Aux1-2-3* (with parameters DG5-DG6-DG7) as "Encod" to display the Encoder speed (it is possible even if tachometer speed feedback is used).
7. PC-tool: there is a new parameter to enable the communication with the PC (DED = PC_Com = OFF/ON)
8. Digital Output configuration: the user can configure one of digital outputs (parameters DO1÷DO6) as "*ParSet*" to display the active parameters set.
9. TENSION regulators: the new parameter CN6 sets the delay of the diameter calculation in relation to the tension regulator start command (COM3).
10. Double set of parameters: there is a new parameter (CDG) to enable/disable the switch of the parameters sets.
11. Profibus-DP: digital outputs OUT1÷OUT6 can be driven directly writing bits 8÷13 of the command word (parameters DO1÷DO6 must be set to "Profib"). Also "reset command" is performed writing bit 7 of the command word.

NOTE: To implement these new functionalities, we have removed some functions rarely used in our applications.
Follow the list of these functions:

12 Selection of the armature current reference from the Rif differential analog input (CA1= RifC12).
It is no more possible to set the armature current reference origin (CA1= RifC12) from the analog input RIF (terminals XM1-33, 34) with sign coming of the logic inputs state COM1 e COM2.

13 Current limit linear recalibration as function of the speed: The recalibration tooks place from the speed set by the parameter DB7 to the maximum speed. (No more from the parameter CE8, that is removed).

14 Maximum speed limited to the base speed value. If it is enabled the switching from speed feedback to armature voltage feedback when the tacho loss protection occurs (CBG = ON), the maximum speed with armature voltage feedback, in the field weakening applications, is limited to the base speed value.
The parameter CC4 takes on the function of the parameter CC5 that is removed.

15 Speed regulator bandwidth recalibration when calculated by speed self-tuning:
The parameter CD8 takes on the function of the parameter CD9 that is removed.

16 Step function. The parameters CEC and CE2 have a new function (see item 5)

17 Kramer function. The parameters CEE and CE7 have been removed.

18 Motor thermal protection recalibration depending on speed. The parameter CE9 has been removed.

19 Speed gain recalibration as function of the diameter.
The parameter CFA has a new function CFA = NoAdVR
The parameter CF5 takes on the function of the parameter CF7 CF5 = ErNAR
The parameters TH5-6-7-8 have been removed.
The parameters TH1-2-3-4- take on a new function
TH1 takes on the function of the parameter TH7 = TcFGp
TH2 takes on the function of the parameter TH8= TcFGi
TH3 = TacRF New function “Emergency ramp” XM1_14 = OFF e CBD = OFF
TH4 = TdcRF New function “Emergency ramp” XM1_14 = OFF e CBD = OFF

20 Fixed time ramp
The parameter CFD takes on the function of the parameter CFG that has been removed, so, CFD = SWCom4
The parameter CF4 takes on the function of the parameter CF6 (weighing time – Load weighing function). CF4= LW_Tm

21 The parameter CF6 takes on the function of the parameter CF8 that is removed, so, CF6 = ErN_T

22 The parameter CF7 is removed.

23 Logic handling of the switchboard - P.L.C. The parameters CHA, CHB, CHC, CHD, CHE,CH1 have been removed.
It is no more possible to set the logic outputs OUT1-6 paramaeters DO1-6 as “CloseP and CloseF

24 The parameter CN5 takes on the function of the parameter CN6, so, CN5 = DiamS (Selection of the operating diameter source).The parameter CN6 has been removed.

25 The parameters COA-CO1-CO2-CO3 are replaced by the parameters CHA-CH1-CH2-CH3

26 Field reversing for Multi-motor Configuration has been removed

NOTE: The firmware 2.6 is available on request.

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DECLARATION OF “CE” CONFORMITY

PREFACE

This manual provides detailed information and the safety rules concerning the installation and startup, use and maintenance of the inverters series SPDM.

The manual has been written for Specialized operators involved in the installation, assembly, startup and maintenance of AC/DC converter SPDM, and it has three different safety typologies, indicated by the specific symbols to identify information requiring special attention:

CAUTION !

Indicates an incorrect action which may determine dangerous situations for the operators. Furthermore, it warns the personnel about possible dangers which may occur during the maintenance operations.



Dangerous Voltage It signals the presence of high voltages with the subsequent risk of death or electric shock for the operators.



It indicates the situations which may endanger the safety of people and/or damage the equipment.

WARNING

It indicates a procedure which should be performed or avoided to perform in a correct way operations of installation, repairing or replacement without damaging the inverter.



It indicates operations in whose field electrostatic discharges must be avoided.



Generic WARNING symbol

REMARK

It is used to explain an instruction, an operation of repairing or other.

✓

Generic REMARK symbol

CAUTION !

Make sure you fully read and understand this MANUAL before performing any intervention on the SPDM.

SAFETY PRECAUTIONS

This section contains information about safety necessary and useful for the personnel operating with the *SPDM*. The information is general and concerns the risks, for operators or for maintenance personnel, related to the operation and maintenance of the converter. The lack of observance of these rules may cause an hazard to the safety of people, with risk of death and of damaging the converter, motor or operating machine.

Before operating with the unit, read the safety instructions.

CAUTION !

All the operations of electric maintenance and installation on the *SPDM* must be performed by qualified technicians.

All the standard electric safety procedures must be respected:

-Never touch inside the converter; only after making sure there is not a high temperature and/or in voltage.



-Always wear protection shoes insulated, in rubber and protection glasses.

-Never work alone.

-Never connect to the system any grounded device of measurement or oscilloscope.

-Never remove safety screens.

-Always pay maximum attention when handling components or performing measurements inside the panel.

- DANGER!

-The SPDM and all the other devices connected MUST BE GROUNDED IN A SUITABLE WAY.

-The voltages on the terminals of output of the SPDM are dangerous, be it when the converter is activated, be it when the same is not operating. Also consider that the motor may turn in any moment as soon as the power supply is connected.

-If the converter is installed in the panel, never operate it with the doors of the panel open.

- DANGER! RISK OF FIRE, SERIOUS DAMAGE!

-The converter $\leq$ 600A has not internal fuses; foresee suitable fuses (see paragraph 7.3 section A for caliper and type immediately upstream the converter). Do not use fuses different from those specified; wrong fuses may cause fire, serious damage to personnel equipment and/or parts connected nearby.
Some units need auxiliary fuses for the separated lines related to the fans and auxiliary circuits.

-Do not apply power to the converter if you presume that inside of the container or of the components humidity has penetrated, dust or caustic/corrosive chemical agents.

- DANGER! RISK OF FIRE, SERIOUS DAMAGE OR INJURIES!

-SPDM are devices of open type and must be installed strictly according to the instructions of this MANUAL and in total agreement with the standards and rules in force.

-Never store flammable material inside, over or near the converter.

- IT IS ABSOLUTELY FORBIDDEN TO



WARNING

-Operate the converter with voltage greater then the 10% of the rated value.

-Apply power to the terminals of output of the SPDM.

-Connect SPDM in parallel, directly on the terminals in output

-Connect capacitive loads to the terminals in output of the SPDM

- DANGER! RISK OF DEATH OR ELECTRIC SHOCK!


DANGER
RISK OF ELECTRIC SHOCK AND DEATH
MUST DISCONNECT ALL POWER, WAIT 3 (THREE) MINUTES BEFORE SERVICING DRIVE OR CONTACT WITH TERMINALS.
FOLLOW INSTRUCTIONS IN MANUAL BEFORE USE.
EARTH GROUND REQUIRED.

Before performing maintenance on the unit, strictly follow these safety points:

-Perform the procedure of block/exclusion of electric power supply and open the main disconnecting switch of the panel.

-Make sure that all the power supplies which reach the SPDM (main and auxiliary power supply) are disconnected before performing maintenance on the converter.

-Await at least thre (3) minutes after disconnecting power supply before performing maintenance on the unit.. Refer to the safety plate existing on all the converters.

-The SPDM is supplied with many automatic functions of reset and restart which can restart automatically the unit. Do not activate these functions if there are dangerous situations.

-Do not change the distances of insulation, nor remove materials and insulation covers.

-Coordinate the voltage and the rated current of the motor and the converter.

-If you must perform some insulation tests on the motor and on the cables, first disconnect the cables from the converter. Do not perform on the components of the SPDM of the test by high potential.

-Pay attention not to damage any part of the SPDM during the movement.

-Protect the converter from atmospheric agents and adverse environmental conditions (temperature, humidity, vibrations, collisions, etc). If you must store temporarily the converter outside, take special precautions (see paragraph 1.4 section A).

CAUTION



The SPDM contains components sensitive to the electrostatic charges; such components may be damaged if handles in a non suitable way. During the operations of maintenance or replacement of the electronic cards, follow the points indicated here below:

Use a kit of maintenance for the electrostatic charges. You must take suitable precautions against the electrostatic discharge (ESD):

- Wear static belts suitably grounded.
- Handle the cards from the edges.
- The cards should not enter in contact with highly insulating materials as plastic sheets, insulating surfaces, parts of synthetic tissues.
- The cards shall be located on conductive surfaces only
- The cards must be packed in conductive sheets before the shipment.

WARRANTY AND LIMITS OF LIABILITY

- WARRANTY:
- For the conditions of warranty please refer to the module “GENERAL CONDITIONS OF WARRANTY” enclosed to the Order Acceptation:
- LIMITS OF LIABILITY:
- Answer Drives S.r.l. shall not be considered liable for missing technical information or errors in this manual, nor for accidental damages due to the use of the information contained in this manual.

A1 GENERAL

A1.1 Introduction

Silcopac D is a family of Graetz three phase bridge compact converters for driving DC motors up to 4000 A, with enhanced features of accuracy and dynamic response. These are fully digital converters, because all control and regulation functions, including the thyristors firing, are performed by a 16 bit microcontroller.

The use of the digital technique gives new important features:

- the converter can be set by software in several ways, so as to match the system requirements;
- a powerful converter diagnostics is provided;
- the user can interact with the SPDM by means of a communication interface which allows to exchange data, commands and other information;
- the current, the speed and e.m.f. loop adjustment can be automatically performed (self-tuning procedure);
- the converter can be included in a centralized digital control system, by means of a serial communication line which allows large amounts of data to be exchanged;
- sophisticated control algorithms can be easily implemented.

The AC line frequency and the phase cyclic rotation do not affect the SPDM's; they can operate at both 2 and 4 quadrants. In the 2 quadrants operating mode the Graetz bridge has 6 thyristors; the motor torque has an unique fixed rotation direction. In the 4 quadrants operating mode the bridge has 12 anti-parallel connected thyristors, without recirculation current; the motor torque has 2 rotation direction.

A single control circuit assembly is provided for all the sizes, from 30 to 4000 A, and it is isolated from the power circuits.

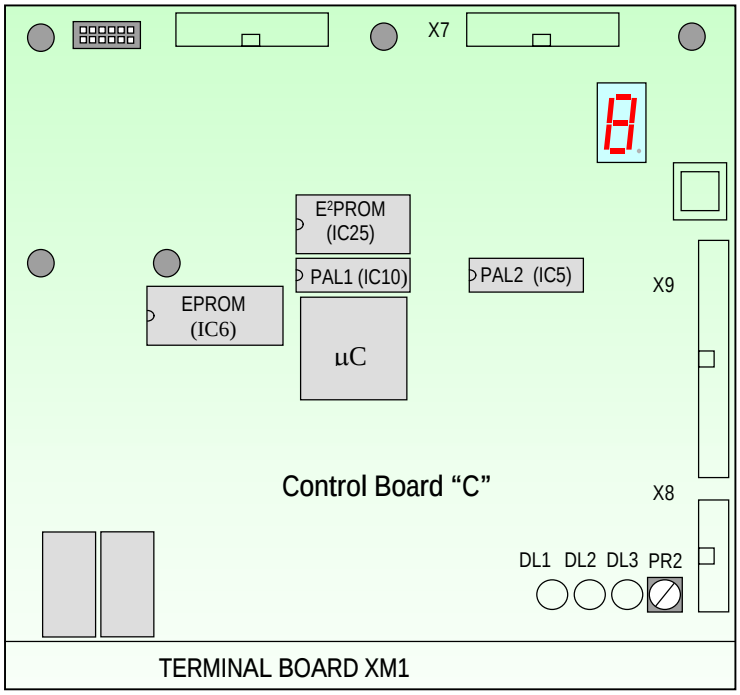
The software is available in the following releases:

		for standard and complex applications.			
enhanced	E	Standard Version	With Profibus DP protocol.	code C1C27N00F27	Release 2.7 F
		For the availability of the Profibus field bus the user must install the SPPB2 Kit)			
dedicated		for special applications ("S" Accurate Speed Ratio, "M" Spindle Control, "L" Ward Leonard).			

Version 2.7 requires that on the control board ("C") the programmed components (PALs) are installed as indicated by the following table.

It is not interchangeable with the previous version 2.6, the replacement needs the parameters programming.

	Control Card
PAL	CONDBE
IC5	L3C85N00600
IC10	L4C20N06L00



Hardware options for motors excitation, both with stationary and weakened field, are available.

A1.2 Documentation

The full documentation of the Silcopac D product consists of the following documents, along with this manual:

NASPD003A00 Parallel of bridges

NAPRFB001 Profibus

IMSPD0025A Ward Leonard and digital Exciters

IMSPD007A Accurate speed ratio; it provides the hardware/software configuration of the "Accurate speed ratio" dedicated version along with commissioning procedures.

IMSPD010A Spindle; it provides the hardware/software configuration of the "Spindle" dedicated version along with commissioning procedures.

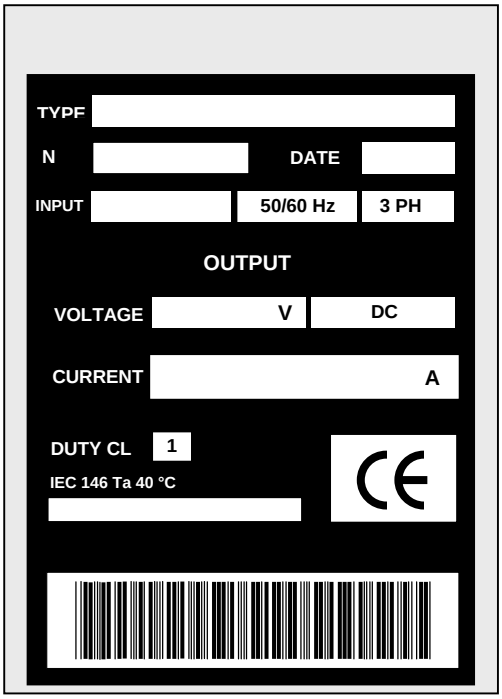
IMSPD026A Diagnostic interface for SPDM via Personal Computer

A1.3 Reception check

When the equipment is received, the packing must not show damages.

Opening the packing, check that the contents may meet the purchasing order verifying the code (chapter 4) on the plate located on the converter side.

Plate:



Serial Number

Power supplì Voltage

Rated output Voltage (V)

Rated output Current (A)

Code

Bar Code

SPDM Identification

Product test date

Line Frequency and Phases

Check that the required options have been included in the packing (chapter 9, section A).

Each equipment is accompanied by the following documents:

Testing report (Code 8CP9998).

Dedicated SW Manual, if any

Parametric sheets (Testing configuration)

Check that the socket mounted components (board C) and the customizing jumpers are in the same configuration as shown by the Converter control document. In the instruction manual you can find a blank copy of the Converter control sheet; we recommend to fill this document to have always a copy of the Converter setting after the setting up.

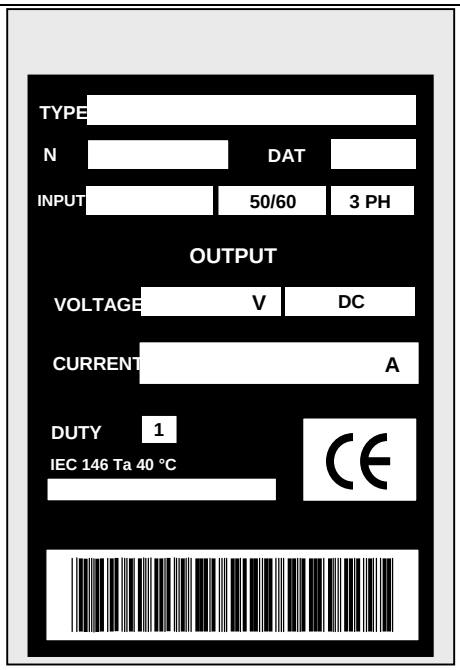
The options (normally furnished apart) are accompanied by the accessories and by the installation and setting up instructions.

Check that no damages occurred to the equipment, verifying the carpentry and the front panel appearance; check for the good status of the inside connections and for the integrity of the electronic boards.

A1.4 Storage

If the converter will not be immediately installed, store it in a clean and dry place, in its primary packing. If these conditions cannot be satisfied, protect the equipment with waterproof sheets.
The storage temperature value shall be within -20°C and +70°C range.

SPDM	SCHEDA PRODOTTO / PRODUCT SHEET MOD. / TYPE 25-9					
A.O. / order conf.						
Consegna richiesta / delivery time:.						
Cliente / Customer.						Euro
Ordine Cliente / P.O.:.						
1	Quantita` / Quantity					
2	Convertitore / Converter					
3	Per motore:		V.			
	For d.c. motor		A.			
4	Rete di alimentazione./ Power supply.					
5	Manuale ist.	❒ Italiano/ Italian	❒ Inglese/English			
	User manual	❒ Francese/ French	❒ Tedesco/ German			
6	Software	❒ Enhanced				
		❒ Ward- Leonard				
		❒ Mandrino/ Spindle				
		❒ Scorr. preciso/ Electr. shaft				
	OPZIONI / OPTIONS					
7	SPDI1	Tastiera / Keypad				
8	SPDI2	Tastiera con connettore CENTRONICS Keypad with CENTRONICS connector				
9	SPDKS	Kit di remotaggio SPDI1/SPDI1 remote kit				
10	SPRI1	Kit remotaggio connettore SPDI1/2 /SPDI1/2 connector remote. kit			28730753	
11	SPDI/O	Espansione I/O digitali / Logic I/O Expansion			25908304	
12	SPDS1	Seriale RS485 / Serial link RS485			25908306	
13	Flat-Cable	SPDI1/2 - SPRI1			20642202	
14	SPAE0	Raddrizzatore di campo / Field rectifier		10 A	25908820	
15	Eccitatrice.	❒ SPAE1		10 A	25908821	
	Exciter.	❒ SPAE		12A	25908819	
		❒ SPAEB		12A	25908822	
		❒ SPAM016U1D		16A	28730747	
		❒ SPAM035U1D		35A	28730748	
		❒ SPAM050U1D		45A	28730749	
16	Reattore monofase			❒ 15 A	20065601	
	Single phase line reactor			❒ 35 A	20065602	
17	Filtro RC /RC filter				254910	
18	Reattore trifase / Thre phase line reactor				223862	
19	ATRS 50	Autotrasformatore Sincronismo		❒ 415-440-480-500/380	204699	
	ATRS 22	Synchronism autotransformer		❒ 220-240/380	206698	
20	Fusibili U.R.	❒ lato CA / AC Side		Q.ta' / Q.ty	20653	
	U.F. Fuse	❒ lato CA / AC Side		Q.ta' / Q.ty	21242	
		❒ lato CC / DC Side		Q.ta' / Q.ty	20653	
		❒ lato CC / DC Side		Q.ta' / Q.ty	21242	
21	Base portafusibile.	❒ 80 mm		Q.ta' / Q.ty	206535	
	Fuse holder	❒ 110 mm		Q.ta' / Q.ty	212430	
22	PS24 (2,2A) Vin=85/265Vac	Alimentatore 24Vc.c. per I/O digitali / LOGICS I/O 24 Vd.c. Power Supply			ELP226084	
23	Manuale / User Manual SW S.		❒Italiano/ Italian	❒		
	Manuale / User Manual SW M.		❒Italiano/Italian	❒		
	Manuale / User Manual SW L .		❒Italiano/ Italian	❒ Inglese/English		
	TOTALE / .TOTAL AMOUNT					

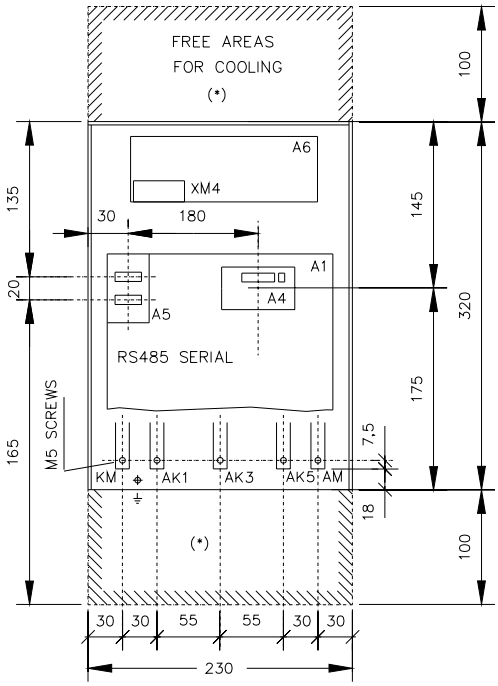


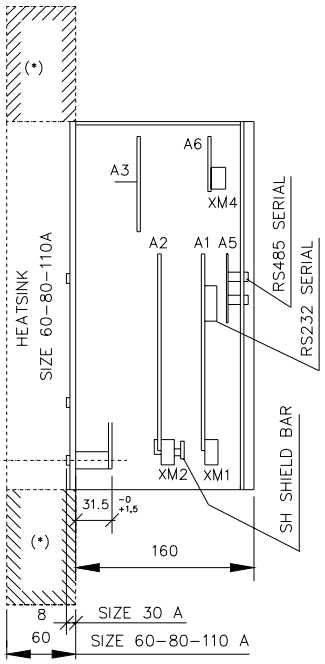
COMPILATORE / EDITOR:	APPROVAZIONE / APPROVED BY:	DATA / DATE:

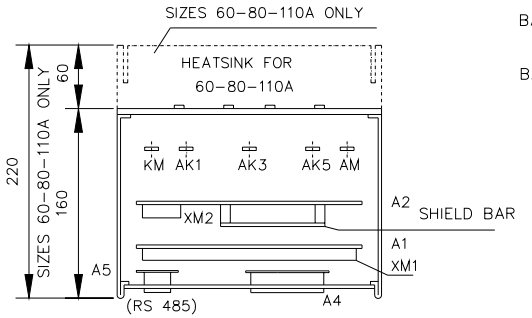
A2 MOUNTING

2.1 Outline dimensions, mounting, safety clearance

Frame I SPDM030-060-080-110

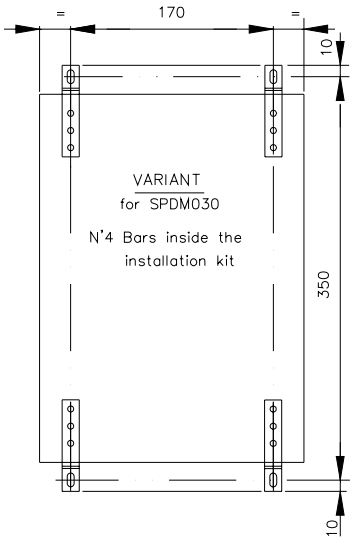


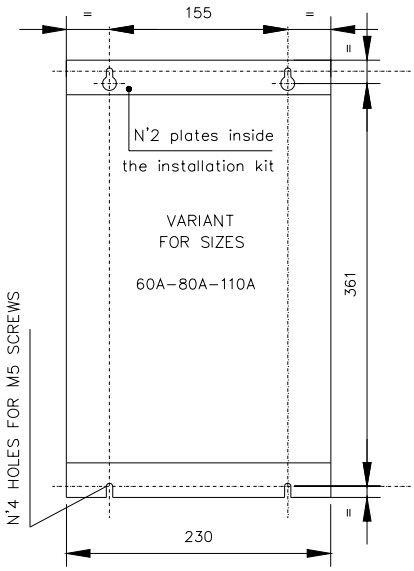


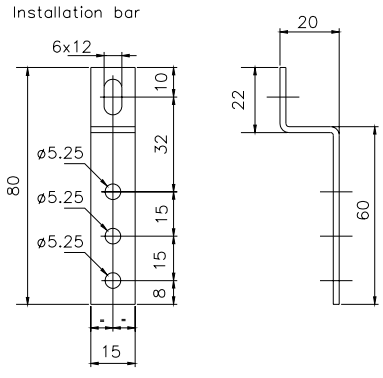


BARS +/- Cu12x1,5 -SPDM030-080-110R, SPDM030U
Cu 12x3 -SPDM080-110U

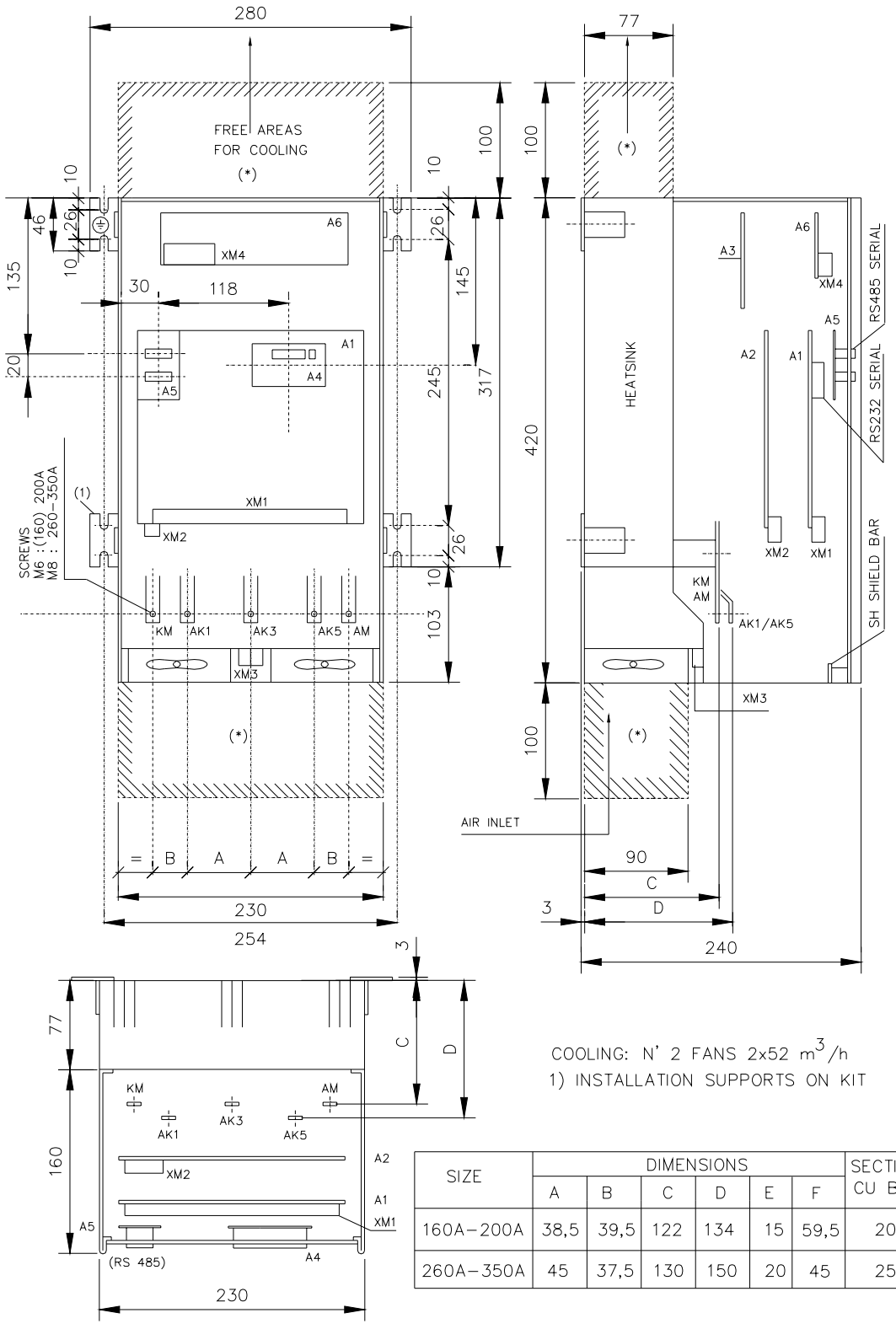
BARS U/V/W Cu 11X1,5





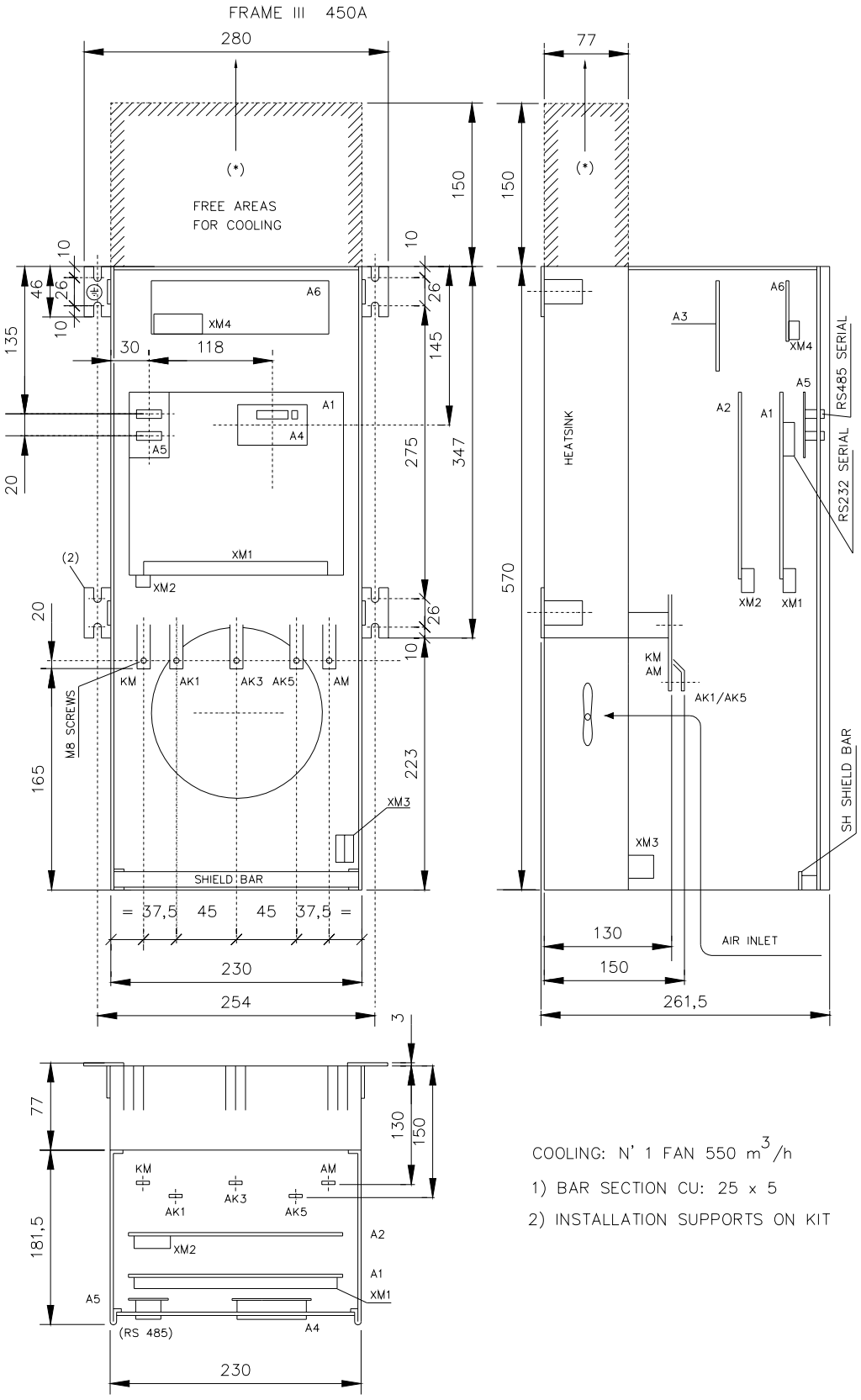


FRAME II 160–200–260–350A



COOLING: N' 2 FANS 2x52 m^3/h
1) INSTALLATION SUPPORTS ON KIT

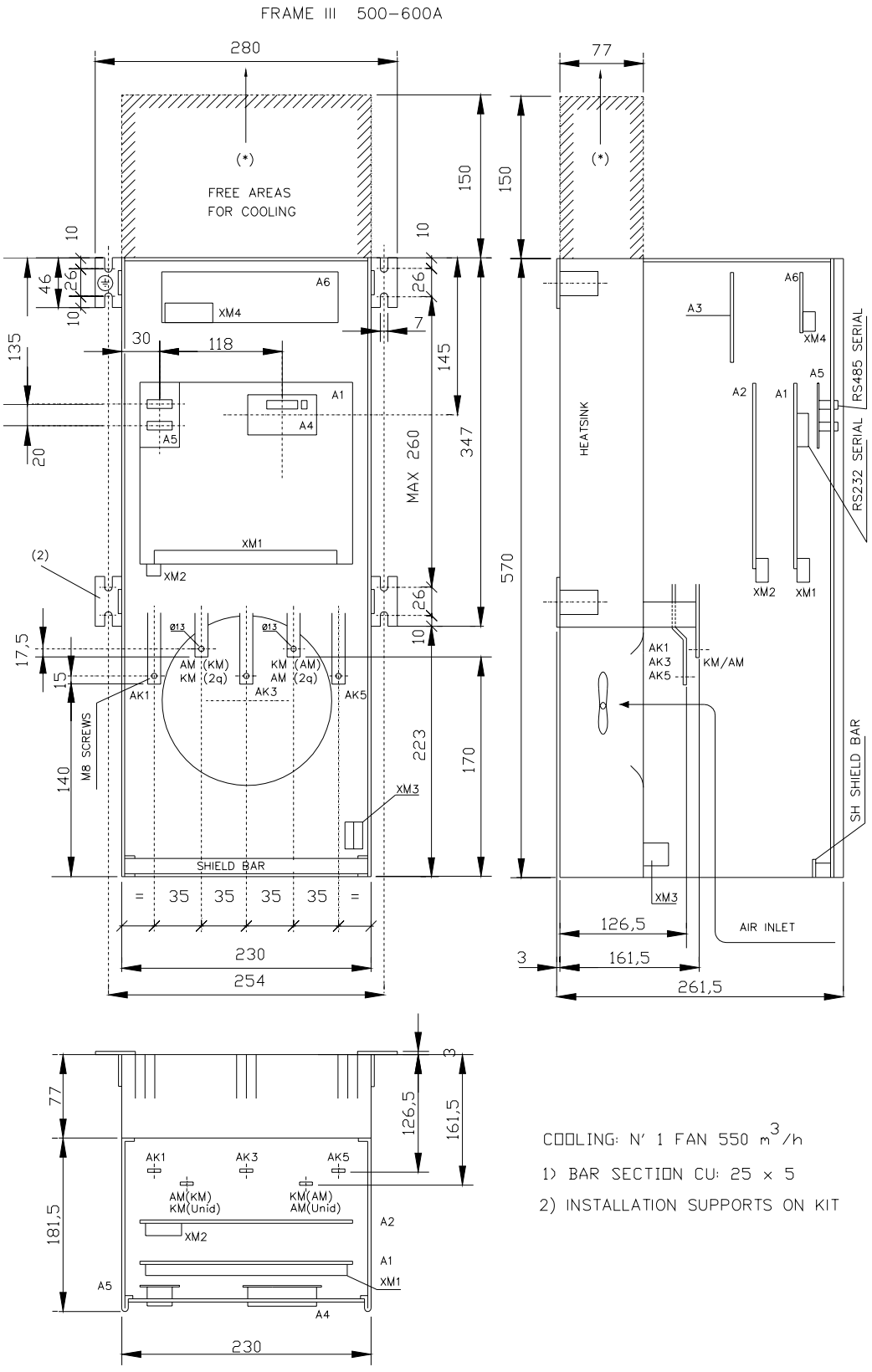
SIZE	DIMENSIONS						SECTION OF CU BARS
	A	B	C	D	E	F	
160A–200A	38,5	39,5	122	134	15	59,5	20 x 3
260A–350A	45	37,5	130	150	20	45	25 x 5



COOLING: N' 1 FAN 550 m^3/h

1) BAR SECTION CU: 25 x 5

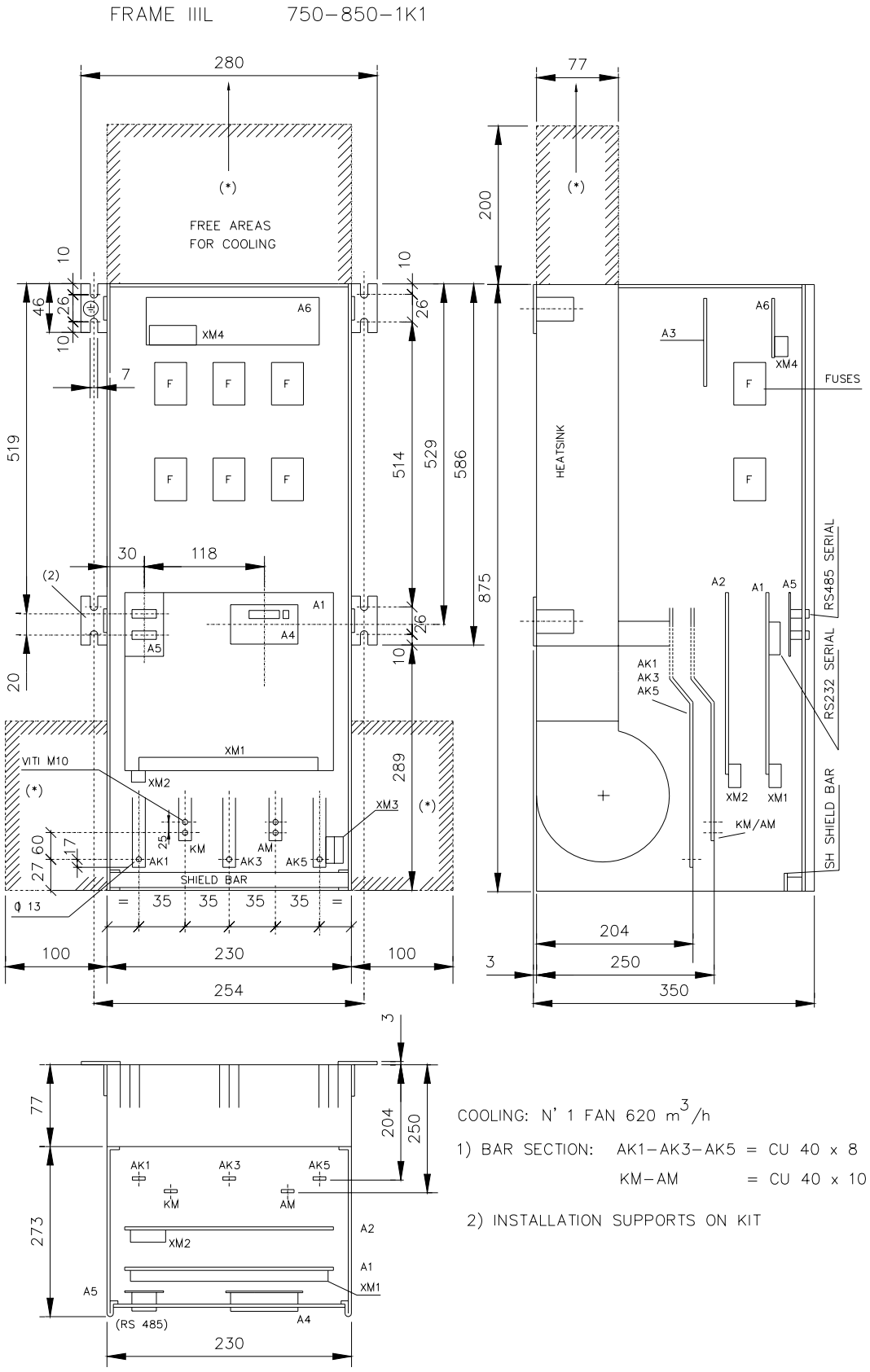
2) INSTALLATION SUPPORTS ON KIT



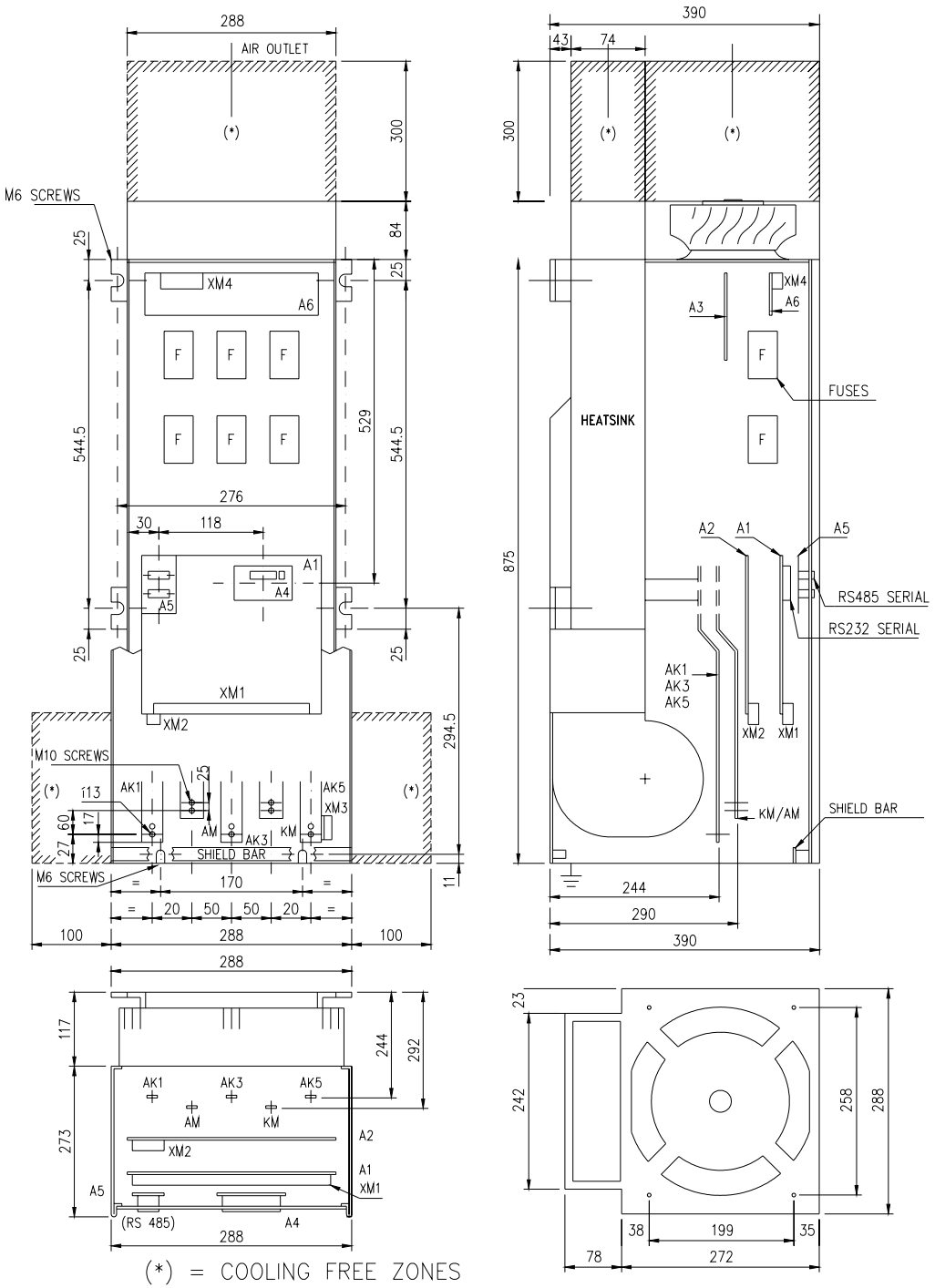
COOLING: N° 1 FAN 550 m^3/h

1) BAR SECTION CU: 25 x 5

2) INSTALLATION SUPPORTS ON KIT


FRAME IIIL 750–850–1K1
280
77
(*)
FREE AREAS
FOR COOLING
200
10
46
26
19
7
519
514
529
586
875
30
118
(2)
20
A6
XM4
A3
FUSES
F
HEATSINK
A1
A4
A5
A2
RS485 SERIAL
RS232 SERIAL
SH SHIELD BAR
AK1
AK3
AK5
XM1
XM2
XM3
VITI M10
KM
AM
KM/AM
SHIELD BAR
289
27
60
17
25
Ø 13
35
100
230
254
204
250
350
3
COOLING: N' 1 FAN 620 m3/h
1) BAR SECTION: AK1–AK3–AK5 = CU 40 x 8
KM–AM = CU 40 x 10
2) INSTALLATION SUPPORTS ON KIT
273
(RS 485)

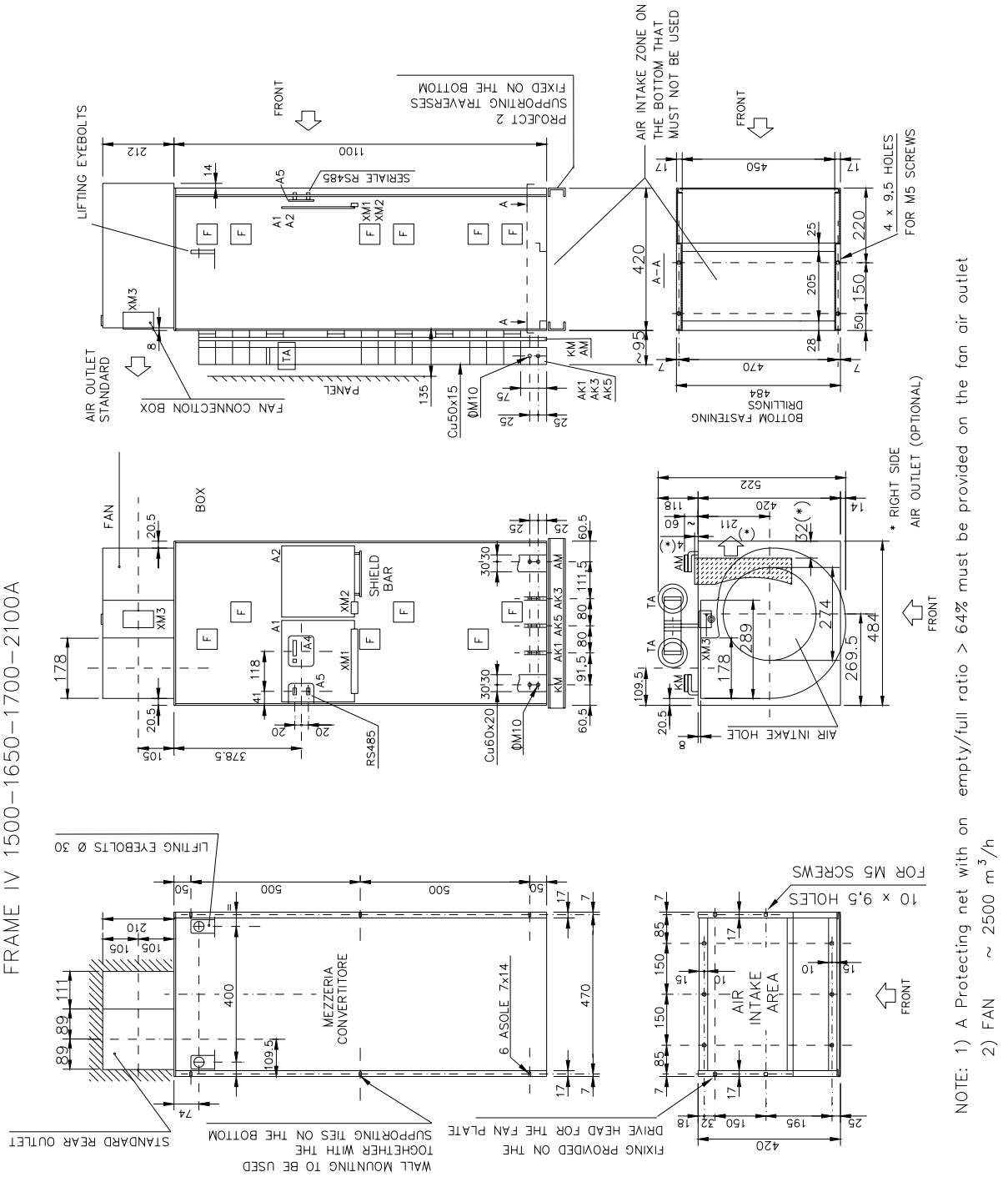
FRAME IIILL SPDM1M0–1M1



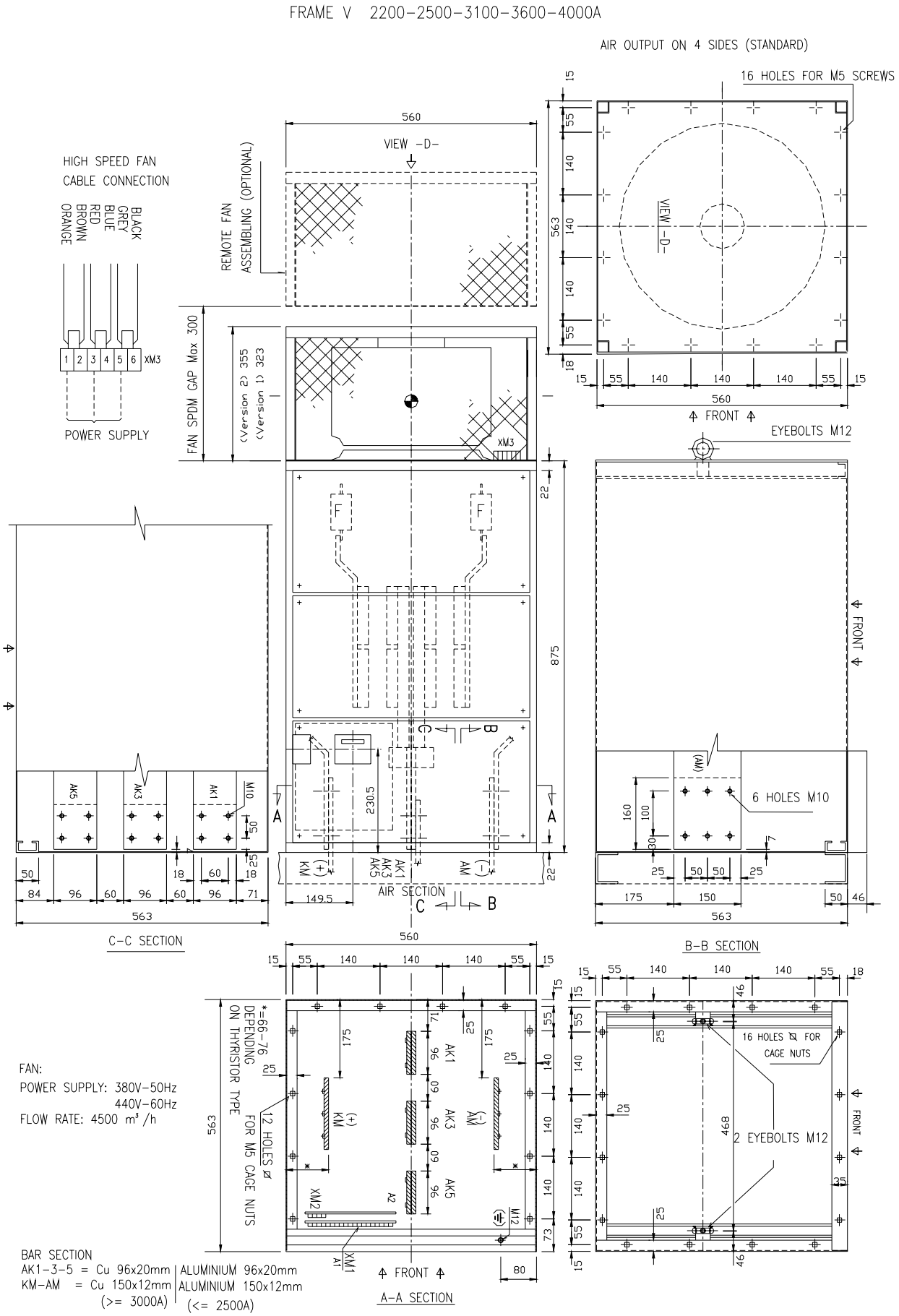
(*) = COOLING FREE ZONES

COOLING : Nø 1 FAN m3/h 855
Nø 1 FAN m3/h 550

1) BARS SECTION KM–AM = Cu 70x10
AK1–AK3–AK5 = Cu 60x8



NOTE: 1) A Protecting net with on empty/full ratio > 64% must be provided on the fan air outlet
2) FAN ~ 2500 m^3/h


FRAME V 2200-2500-3100-3600-4000A
AIR OUTPUT ON 4 SIDES (STANDARD)
16 HOLES FOR M5 SCREWS
VIEW -D-
HIGH SPEED FAN
CABLE CONNECTION
ORANGE
BROWN
RED
BLUE
GREY
BLACK
1 2 3 4 5 6 XM3
POWER SUPPLY
REMOTE FAN
ASSEMBLING (OPTIONAL)
FAN SPDM GAP Max 300
(Version 2) 355
(Version 1) 323
XM3
FRONT
EYEBOLTS M12
6 HOLES M10
AIR SECTION
C-C SECTION
B-B SECTION
A-A SECTION
FAN:
POWER SUPPLY: 380V-50Hz
440V-60Hz
FLOW RATE: 4500 m³/h
12 HOLES Ø *-66-76 DEPENDING ON THYRISTOR TYPE FOR M5 CAGE NUTS
16 HOLES Ø FOR CAGE NUTS
2 EYEBOLTS M12
BAR SECTION
AK1-3-5 = Cu 96x20mm | ALUMINIUM 96x20mm
KM-AM = Cu 150x12mm | ALUMINIUM 150x12mm
(>= 3000A) (<= 2500A)

NOTES

Frame IV (SPDM 1K5-1K6-1K7-2K0)

Two versions are available:

Standard version	With current transducer installed on the SPDM and collector bars AC DC installed.
Optional version (suffix 51)	With loose current transducer and collector bars AC DC not installed.

Fan

The fan is delivered loose (not installed on the SPDM).
The standard mounting plate (ELC209037) of the fan is designed for rear side (standard) or front side air outlet .
A fan mounting plate (ELC209037) with air outlet on the right side is available as option.

Frame V (SPDM2K2-2K5-3K1-3K6-4K0)

FAN

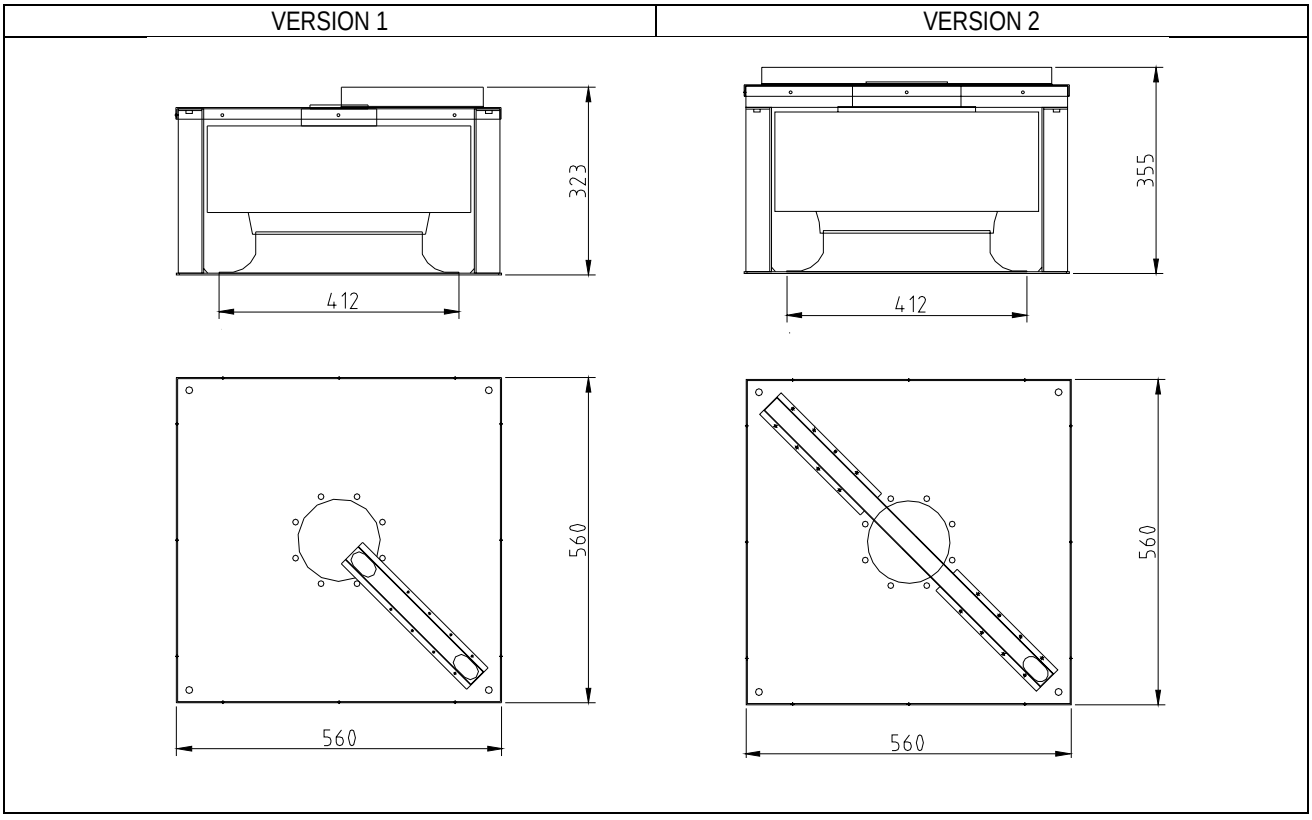
The fan is delivered loose (not installed on the SPDM).

Up to 09.16.2005 two versions was available.

1. Version 1: standard .
2. Version 2: optional, (indicated with suffix 50 on the identification code).

After this date the version two is available only. The identification code for every SPDM will have the suffix 50.

NOTE: the remarks above mentioned are valid also for the RTT frame V.



A2.2 Weights and dimensions

Silcopac D type	Frame	width mm	height mm	depth mm	weight kg
Two quadrants (uni-directionals)					
SPDM030Ux	I	230	320	168	4
SPDM060/80Ux	I	230	320	220	7
SPDM110Ux	I	230	320	220	10
SPDM160/200Ux	II	230	420	240	13
SPDM260Ux	II	230	420	240	13
SPDM350Ux	II	230	420	240	14
SPDM450Ux	III	230	570	262	18
SPDM500/600Ux	III	230	570	262	21
SPDM850Ux	IIIL	230	875	350	46
SPDM1M0/1M1Ux	IIILL	288	875	390	47
SPDM1K5/1K6Ux	IV	484	1100(1)	420	100
SPDM1K7/2K1Ux	IV	484	1100(1)	420	100
SPDM2K2Ux	V	560	875(1)	563	150
SPDM2K5Ux	V	560	875(1)	563	150
SPDM3K1UX	V	560	875(1)	563	180
SPDM3K6Ux	V	560	875(1)	563	230
SPDM4K0Ux	V	560	875(1)	563	230
Four quadrants (reversible)					
SPDM030Rx	I	230	320	168	5
SPDM060/80Rx	I	230	320	220	8
SPDM110Rx	I	230	320	220	11
SPDM160/200Rx	II	230	420	240	15
SPDM260Rx	II	230	420	240	15
SPDM350Rx	II	230	420	240	17
SPDM450Rx	III	230	570	262	20
SPDM500/600Rx	III	230	570	262	26
SPDM750Rx	IIIL	230	875	350	57
SPDM850Rx	IIIL	230	875	350	57
SPDM1M0/1M1Rx	IIILL	288	875	390	58
SPDM1K5Rx	IV	484	1100(+212)	420	125
SPDM1K6Rx	IV	484	1100(+212)	420	125
SPDM1K7Rx	IV	484	1100(+212)	420	125
SPDM2K1Rx	IV	484	1100(+212)	420	125
SPDM2K2Rx	V	560	875(+300)	563	150
SPDM2K5Rx	V	560	875(+300)	563	200
SPDM3K1RX	V	560	875(+300)	563	270
SPDM3K6Rx	V	560	875(+300)	563	320
SPDM4K0Rx	V	560	875(+300)	563	320

A3 TECHNICAL DATA

Silcopac D	Frame	Rated	Losses	Blower	Power supply					
type		Current			G	H	K	W	M	N
(1)		A CC	W		380-500V	600V	690V	750V	850V	950V
Two quadrants										
SPDM030Ux		30	120		X	X				
SPDM060/80Ux	I	60/80	200/260		X	X				
SPDM110Ux		110	350		X	X				
SPDM160/200Ux		160/200	500/630	230V 1ph	X	X				
SPDM260Ux		260	860	50/60Hz	X	X				
SPDM350Ux		350	1100	0,3A	X	X				
SPDM450Ux	III	450	1450	230V 1ph	X	X				
SPDM500Ux		500	1500	50/60Hz			X			
SPDM600Ux		600	1850	0,35A	X	X				
SPDM850Ux	IIIL	850	3100		X		X			
SPDM1M0Ux		1000	3800	50/60Hz	X	X				
SPDM1M1Ux	IIILL	1100	4000	0,88A	X	X				
SPDM1K5Ux	IV	1500	5400	400V 3ph 50Hz			X	X	X	X
SPDM1K6Ux		1650	5900	440V 3ph 60Hz	X					
SPDM1K7Ux		1700	6000	2,2A			X	X	X	X
SPDM2K1Ux		2100	7500		X					
SPDM2K2Ux	V	2200	7800	400V 3ph 50Hz			X	X	X	X
SPDM2K5Ux		2500	8900	1,7A	X		X	X	X	X
SPDM3K1Ux		3100	11000	440V3ph 60Hz	X		X	X	X	X
SPDM3K6Ux		3600	12700	2A	X		X	X	X	X
SPDM4K0Ux		4000	14100		X		X	X		
Four quadrants										
SPDM030Rx		30	120		X	X				
SPDM060/80Rx	I	60/80	200/260		X	X				
SPDM110Rx		110	350		X	X				
SPDM160/200Rx		160/200	500/630	230V 1ph	X	X				
SPDM260Rx		260	860	50/60Hz	X	X				
SPDM350Rx		350	1100	0,3A	X	X				
SPDM450Rx		450	1450	220-230V 1ph	X	X				
SPDM500Rx	III	500	1500	50/60Hz			X			
SPDM600Rx		600	1850	0,35A	X	X				
SPDM750Rx	IIIL	850	3100				X			
SPDM850Rx		850	3100	220-230V	X	X				
SPDM1M0Rx	IIILL	1000	3800	0,88A	X	X				
SPDM1M1Rx		1100	4000		X	X				
SPDM1K5Rx	IV	1500	5400	400V 3ph 50Hz			X	X	X	X
SPDM1K6Rx		1650	5900	440V 3ph 60Hz	X					
SPDM1K7Rx		1700	6000	2,2A			X	X	X	X
SPDM2K1Rx		2100	7500		X					
SPDM2K2Rx		2200	7800	400V 3ph 50Hz			X	X	X	X
SPDM2K5Rx		2500	8900	1,7A	X		X	X	X	X
SPDM3K1Rx	V	3100	11000	440V3ph 60Hz	X		X	X	X	X
SPDM3K6Rx		3600	12700	2A	X		X	X	X	X
SPDM4K0Rx		4000	14100		X		X	X		

NOTE

For output current greater than 4000A, thyristors bridges, named RTT, are available. The RTT are designed with the same output current and dimensions of the SPDM frames IV and V. Paralleling the RTT with equivalent SPDM it is possible to obtain drives with output current up to 8000A (See Appendix G).

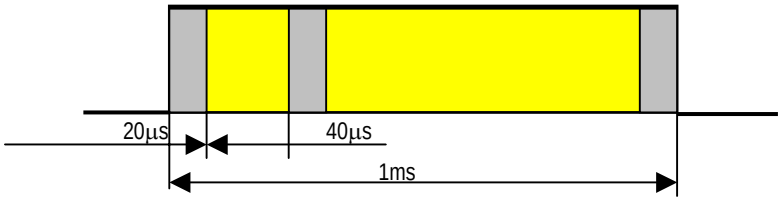
Notes:		Vin	Two quadrants Vout	Four quadrants Vout
(1)	x= G	3x400 V	460 Vcc	420 Vcc
		3x440 V	510 Vcc	460 Vcc
		3x460 V	530 Vcc	480 Vcc
		3x500 V	570 Vcc	520 Vcc
	x=H	3x600 V	700 Vcc	630 Vcc
	x=K	3x690 V	800 Vcc	720 Vcc
	x=W	3x750 V	860 Vcc	800 Vcc
	x=M	3x850 V	980 Vcc	9000 Vcc
	x=N	3x950 V	1090 Vcc	1000 Vcc

AC main voltage:	power	G(380-500V) - H(600V) - K(660V) - W(750V) – M(850V) – N(950V) ±10%		
	control	380 V ±15% -- 400 V +10% - 20% 30 VA		
	A transformer must be used with an other power supply voltage (primary: delta winding)			
Frequency:	45 – 65 Hz	Automatic matching to the frequency value and to the phase cyclic rotation.		
Cosφ1: (typical, max)	$\cos\varphi 1 \cong \frac{U_{d.c.}}{1.35 \cdot U_{vo}}$	0.86 SPDM 2 quadrants		
		0.78 SPDM 4 quadrants		
		Where Udc = Output voltage, Uvo = No load power supplì voltage		
Speed static Accuracy:	with tacho feedback	0.1 %	at contemporary variations of:	AC main voltage ±10 %
	with encoder feedback	0.01 %		load current 0 -100 %
	with voltage feedback	2 %		load current 10° C
Speed resolution with encoder:	0.005%			
Dead zone on bridge reversing:	max. 3,3 ms			
Max current regulator bandwidth:	400 rad/s			
Max speed regulator bandwidth:	60 rad/s			

Analog input and output resolution:

Signal	I/O	Terminals	Resolution
Rif	Input		10 bit + sign
If, Ean1, Ean2	Inputs	XM1-28, XM1-29, XM1-30	9 bit + sign
Tacho Dynamo	Input	XM1-26	10 bit + sign
PWM1, PWM2, PWM3	Outputs	XM1-37, XM1-39, XM1-40	8 bit + sign
Operating Temperature:	0 - 40°C	Decrease the nominal current by 1.2% for each °C between 40°C and 65°C max	
Altitude (above sea level):	0 - 1000m	Decrease the nominal current by 1% every 100 m between 1000 and 3000 m m	
Storage temperature: -20 +70°C			
Relative humidity:	95% max	without condensate	

PULSES TRANSFORMER 12V—1A



A4 ORDERING INFORMATION

A4.1 Identification code

The Silcopac D is identified by the following part number:

SPDM	X X X	X	X	X	X X
				SOFTWARE	**OPTIONS**
				E = enhanced S = accurate speed ratio M = spindle	10 = Control back-up 24V N10 = Frame IV with AL24 internal mounted 20 = Master x RTT (con PPRCRC ①) 40 = Fuse trip indicator (**) 50 = Frame V with version 2 fan 51 = Frame IV (CTloose) without collector bars. 54 = Frame IV: air outlet on the right side 60 = Marine application 61 = Frame V: marine application A/V mounth FL = Fuseless
			POWER SUPPLY VOLTAGE		
			G = 380-500 V H = 600 V K = 690 V W= 750 V M = 850 N = 950		
		OPERATING MODE			
		U = 2 quadrant operation R = 4 quadrant operation			

	CURRENT (A)	input voltage	size
	030	G – H	I
	060	G – H	I
	080	G – H	I
	110	G – H	I
	160	G – H	II
	200	G – H	II
	260	G – H	II
	350	G – H	II
	450	G – H	III
	500	K	III
	600	G – H	III
	750	K(*)	IIIL
	850	G – (K #)	IIIL
	1M0	G – H	IIIL
	1M	G – H	IIILL
	1K5	K – W –M - N	IV
	1K6	G	IV
	1K7	K – W –M - N	IV
	2K1	G	IV
	2K2	K – W –M - N	V
	2K5	G –K - W –M - N	V
	3K1	G – K – W –M - N	V
	3K6	G – K – W –M - N	V
	4K0	G – K – W	V

(*) 4 quadrants only (#) 2 quadrants only

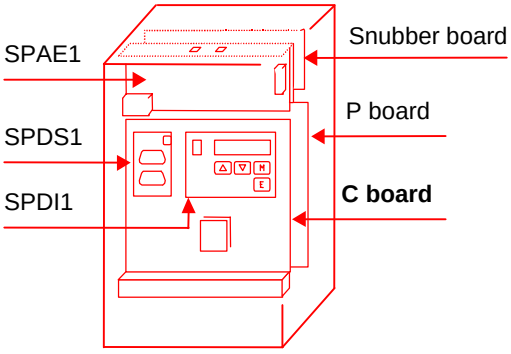
① See "Parallel Bridges Manual" NASPD003A00

(**) Available for frames IV and V only, it consists of six micro-switch installed on the fuses. The NC contacts are connected in series and the two terminal are free; it is at user charge the connection to a cabinet terminal board.

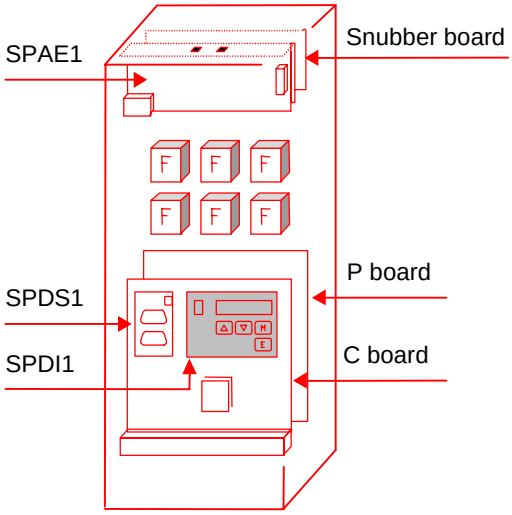
Example: 200A drive, 4 quadrants, power supply 400V, standard software SPDM200RGE

A5 INTERNAL CONNECTIONS

A5.1 Board locations

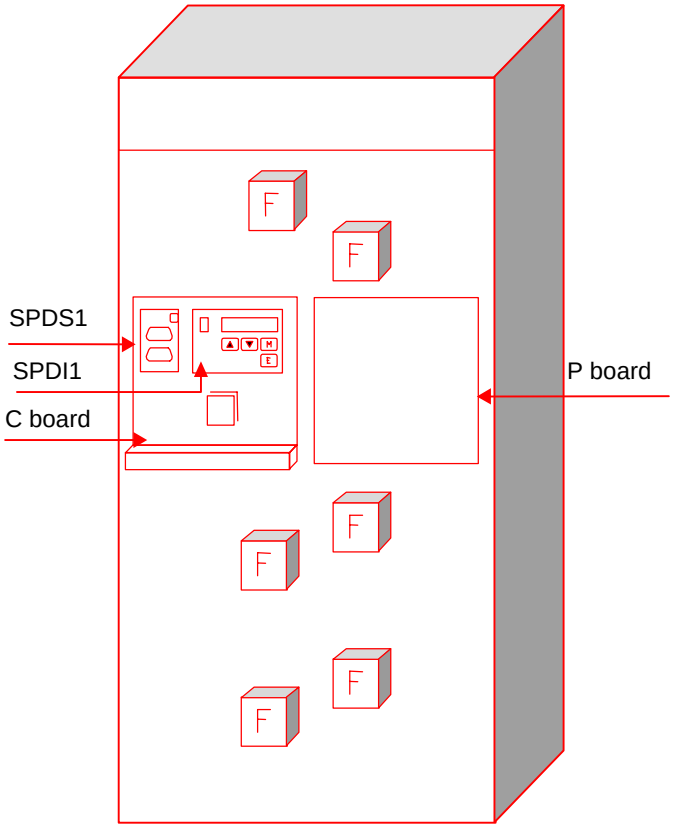


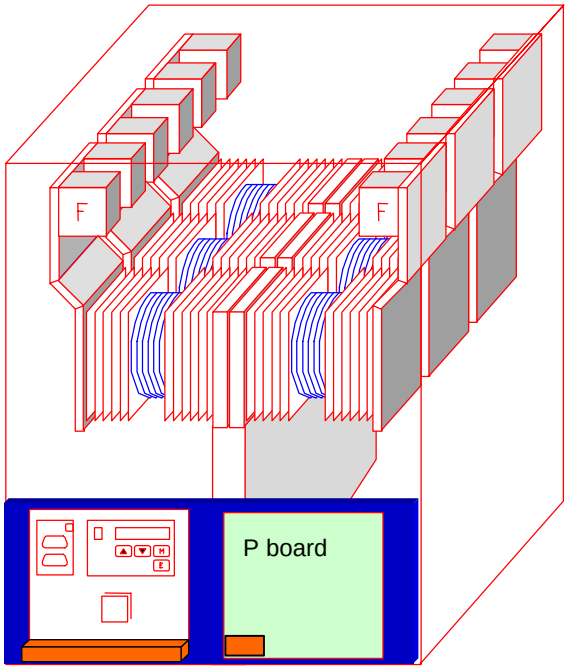
SILCOPAC
Size I, II, III



SILCOPAC
Size III L, III LL

SILCOPAC
Size IV



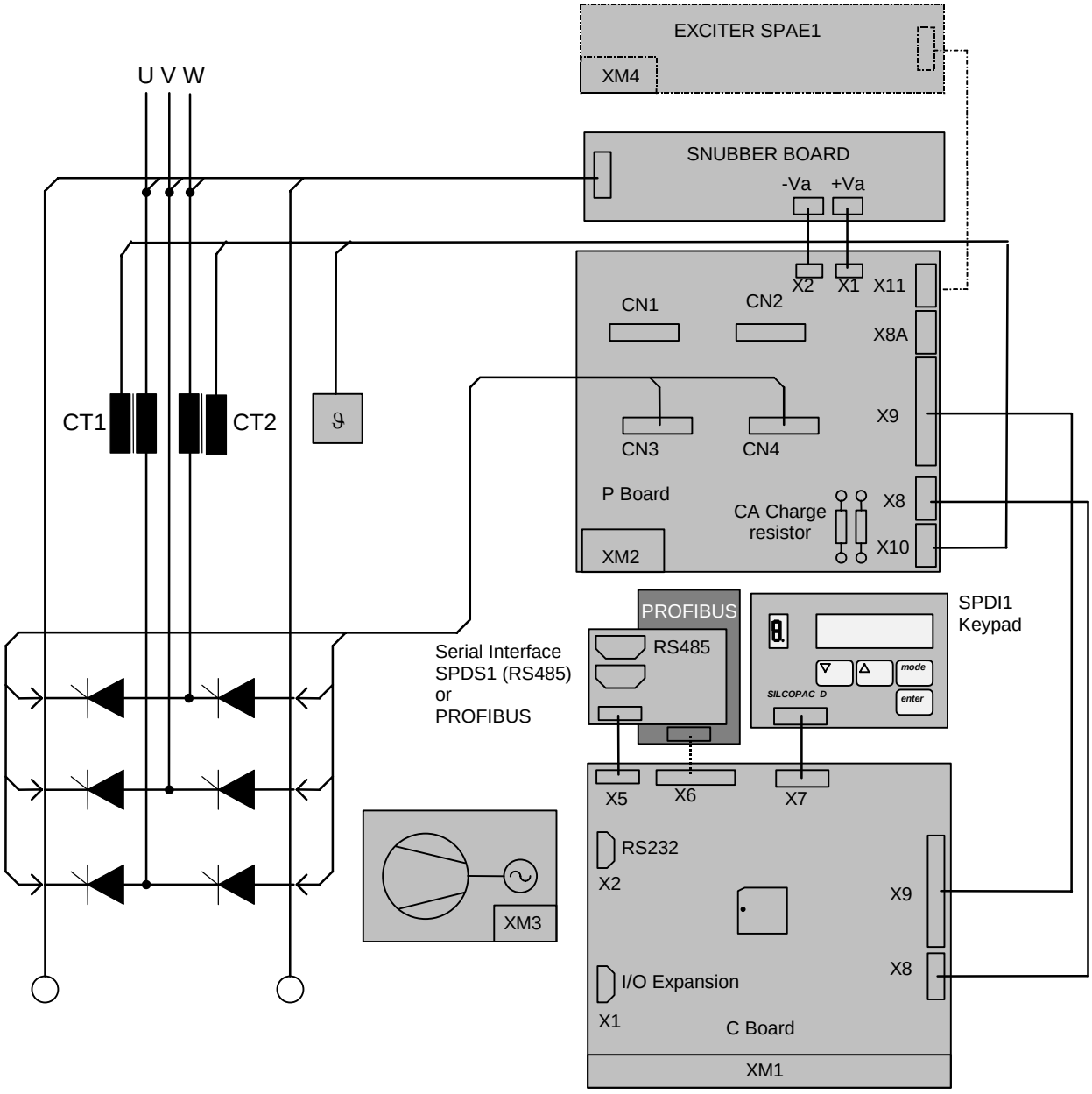


SILCOPAC
Size V

A5.2 Internal connections

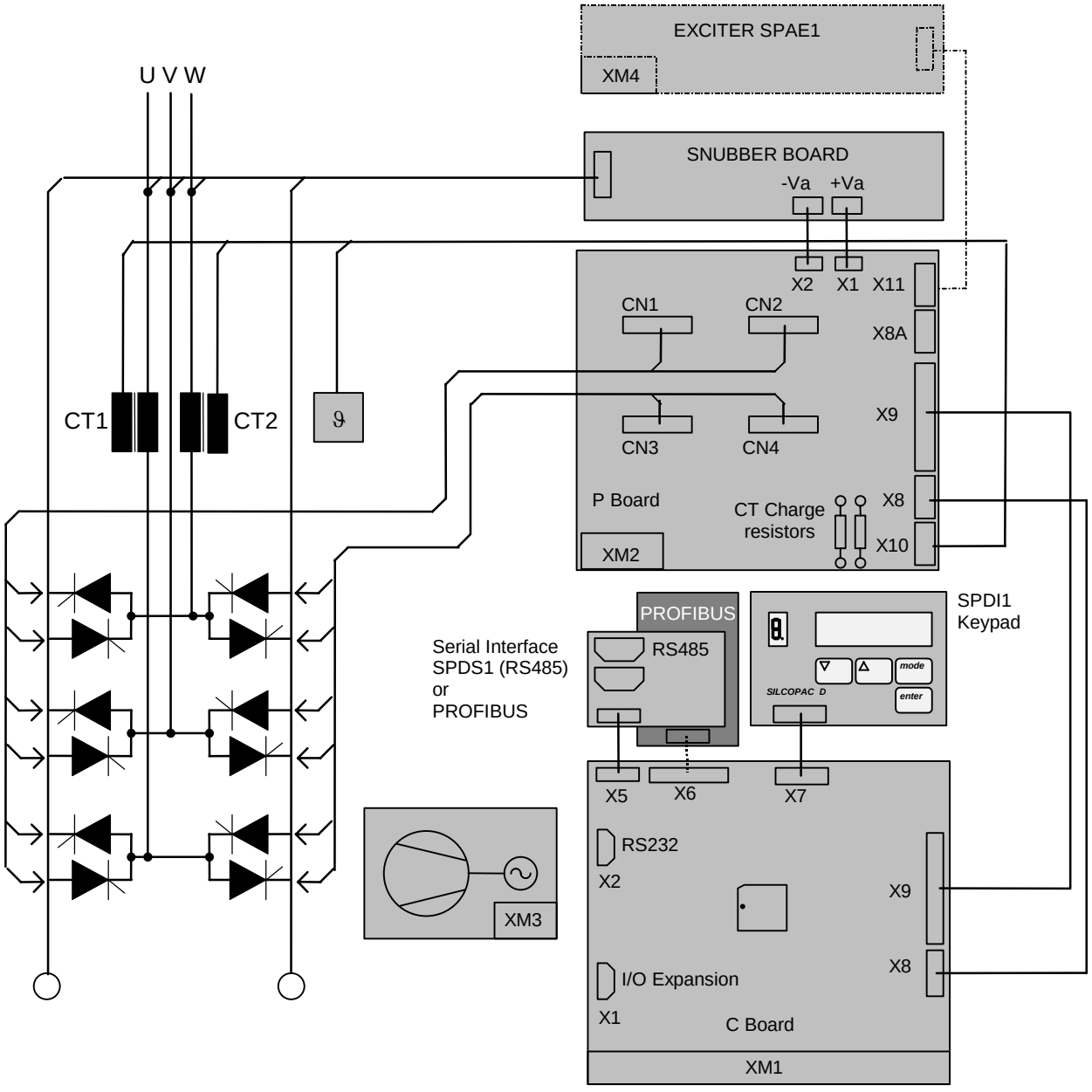
A5.2.1 Two quadrant Silcopac D

C board	= ELC45244601	CONDB	
P board	= 260580	BPU 50 A	(AC main <= 500 V)
	= 260581	BPU 66 A	(AC main = 600 - 690 V)
	= 1000002327	BPU 85 A	(AC main = 700 - 850 V)
	= ELC452567	BPU 1K A	(AC main = 950 V)



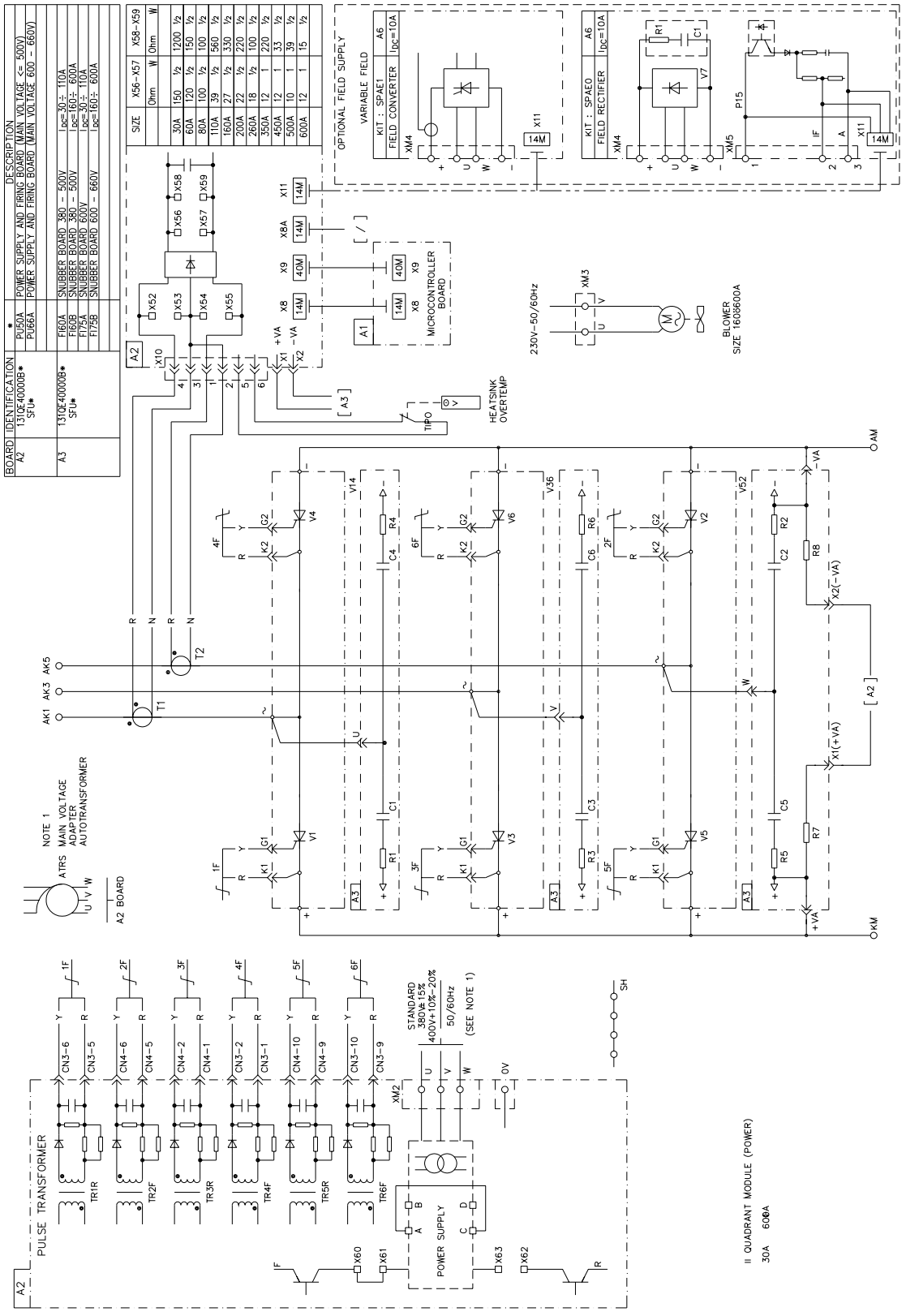
A5.2.2 Four quadrant Silcopac D

C board	= ELC45244601	CONDB	
P board	= 260561	BPR 50 A	(AC main <= 500 V)
	= 260562	BPR 66 A	(AC main = 600 - 690 V)
	= ELC452445	BPR 85 A	(AC main = 700 - 850 V)
	= ELC452463	BPR 1K A	(AC main = 950 V)

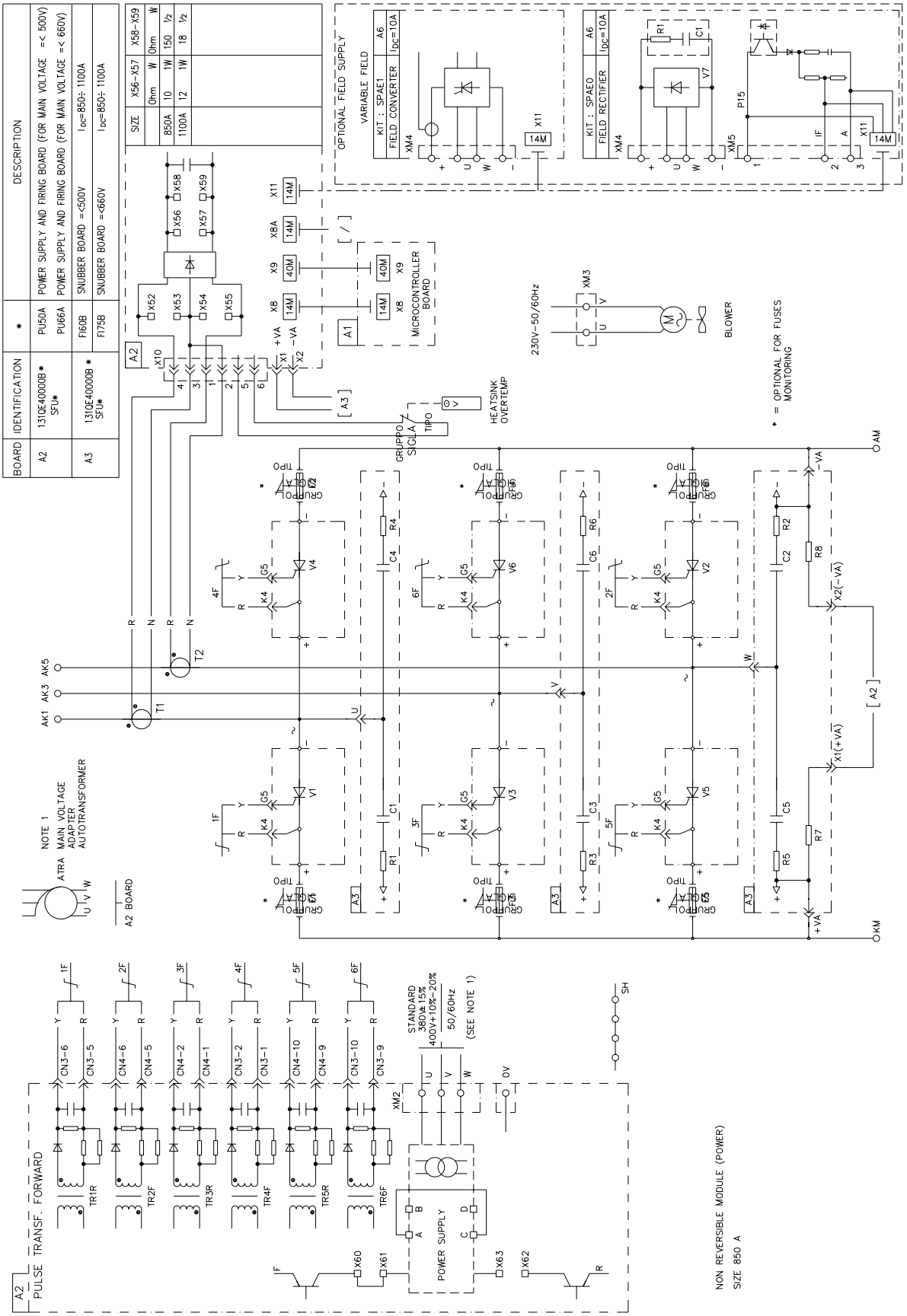


A6 POWER CONNECTIONS DIAGRAMS

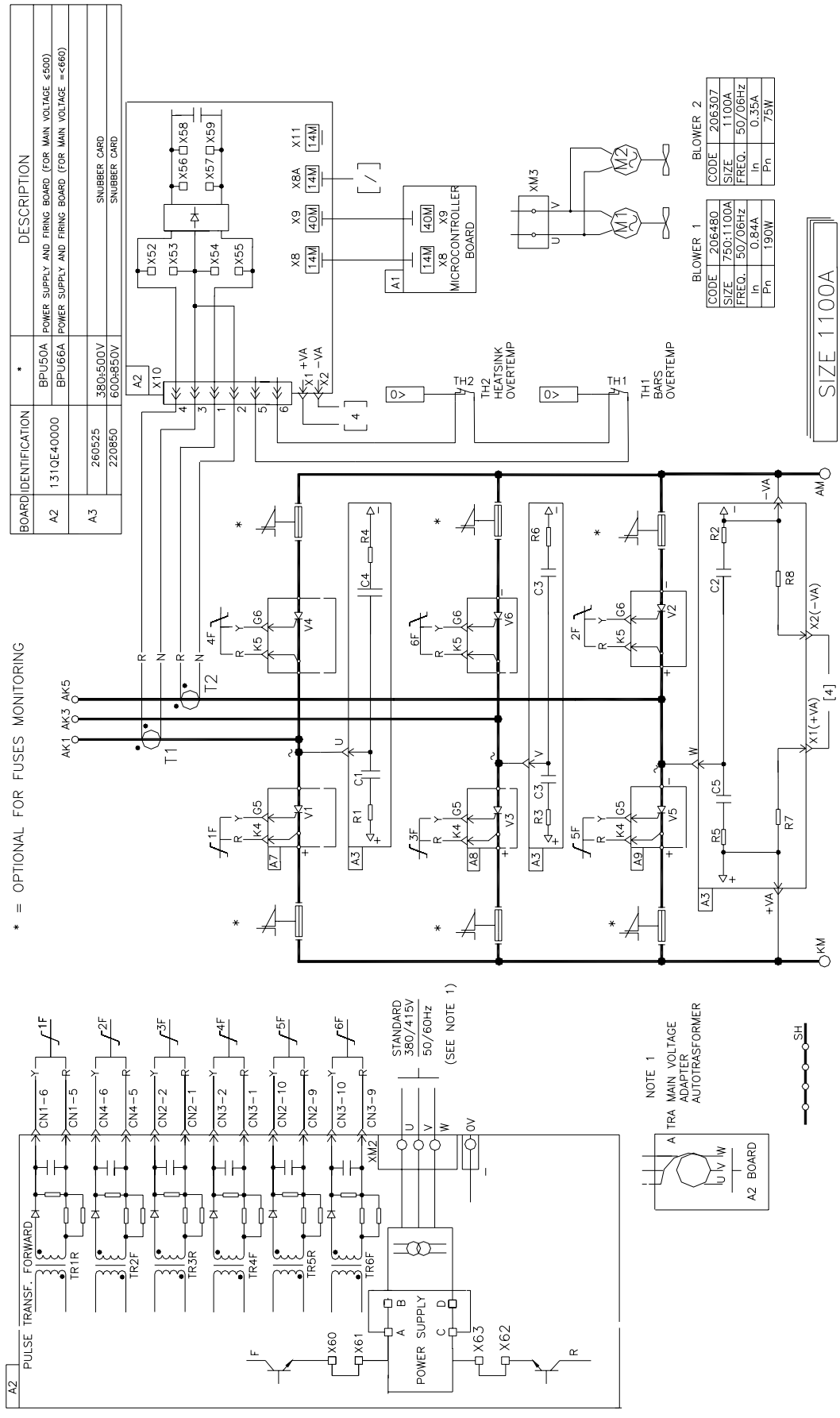
FRAME 30A÷600A Two quadrant



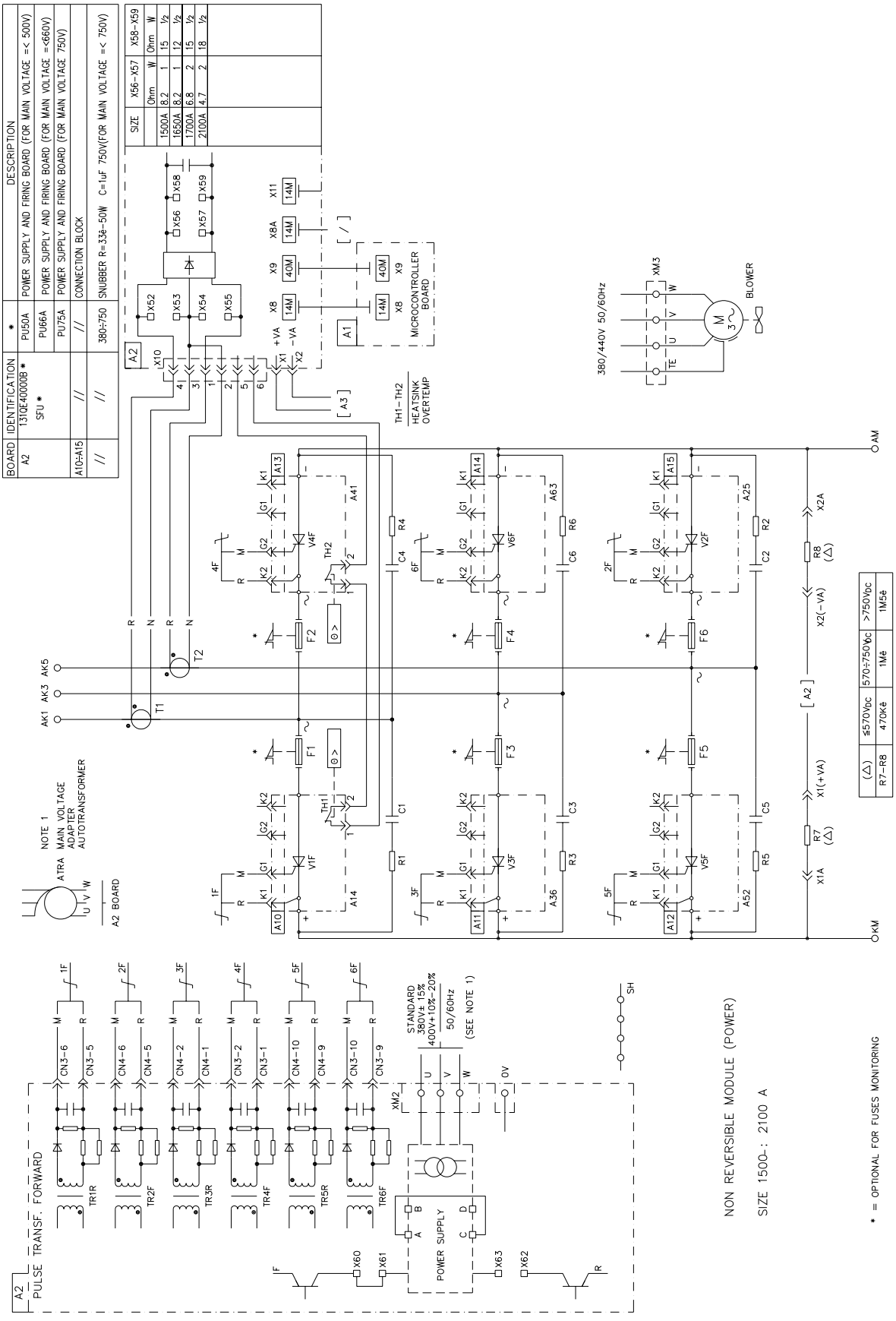
FRAME 850A-1100A (SPDM1K1) Two quadrant



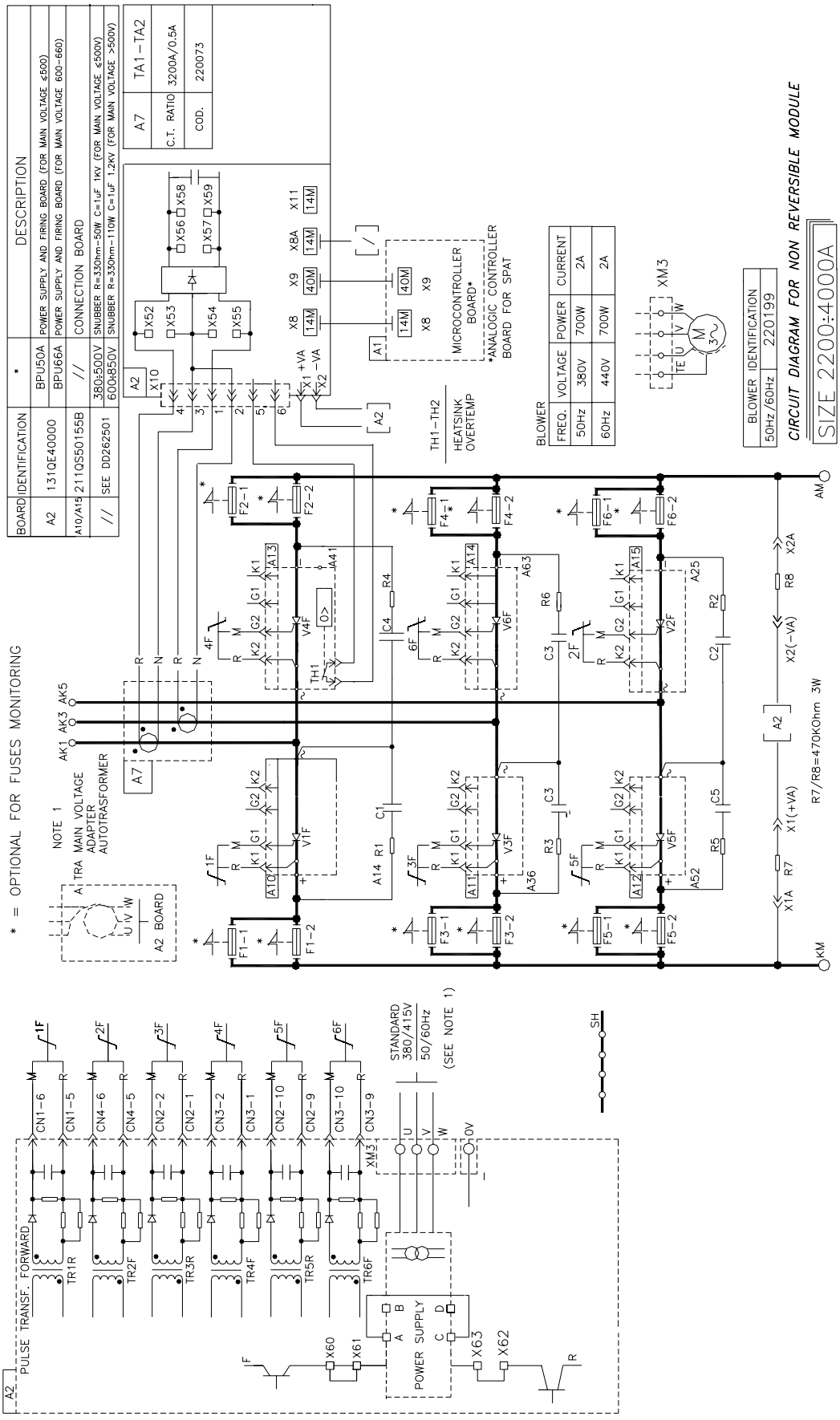
FRAME 1000A-1100A (SPDM1M0-1M1) Two quadrant


BOARD IDENTIFICATION * DESCRIPTION
A2 131QE40000 BPU50A POWER SUPPLY AND FIRING BOARD (FOR MAIN VOLTAGE ≤500)
BPU66A POWER SUPPLY AND FIRING BOARD (FOR MAIN VOLTAGE =<660)
A3 260525 380÷500V SNUBBER CARD
220850 600÷850V SNUBBER CARD
* = OPTIONAL FOR FUSES MONITORING
BLOWER 1 CODE 206480 SIZE 750÷1100A FREQ. 50/06Hz In 0.84A Pn 190W
BLOWER 2 CODE 206307 SIZE 1100A FREQ. 50/06Hz In 0.35A Pn 75W
SIZE 1100A
TH1 BARS OVERTEMP
TH2 HEATSINK OVERTEMP
MICROCONTROLLER BOARD
PULSE TRANSF. FORWARD
POWER SUPPLY
STANDARD 380/415V 50/60Hz (SEE NOTE 1)
NOTE 1 TRA MAIN VOLTAGE ADAPTER AUTOTRASFORMER
A2 BOARD

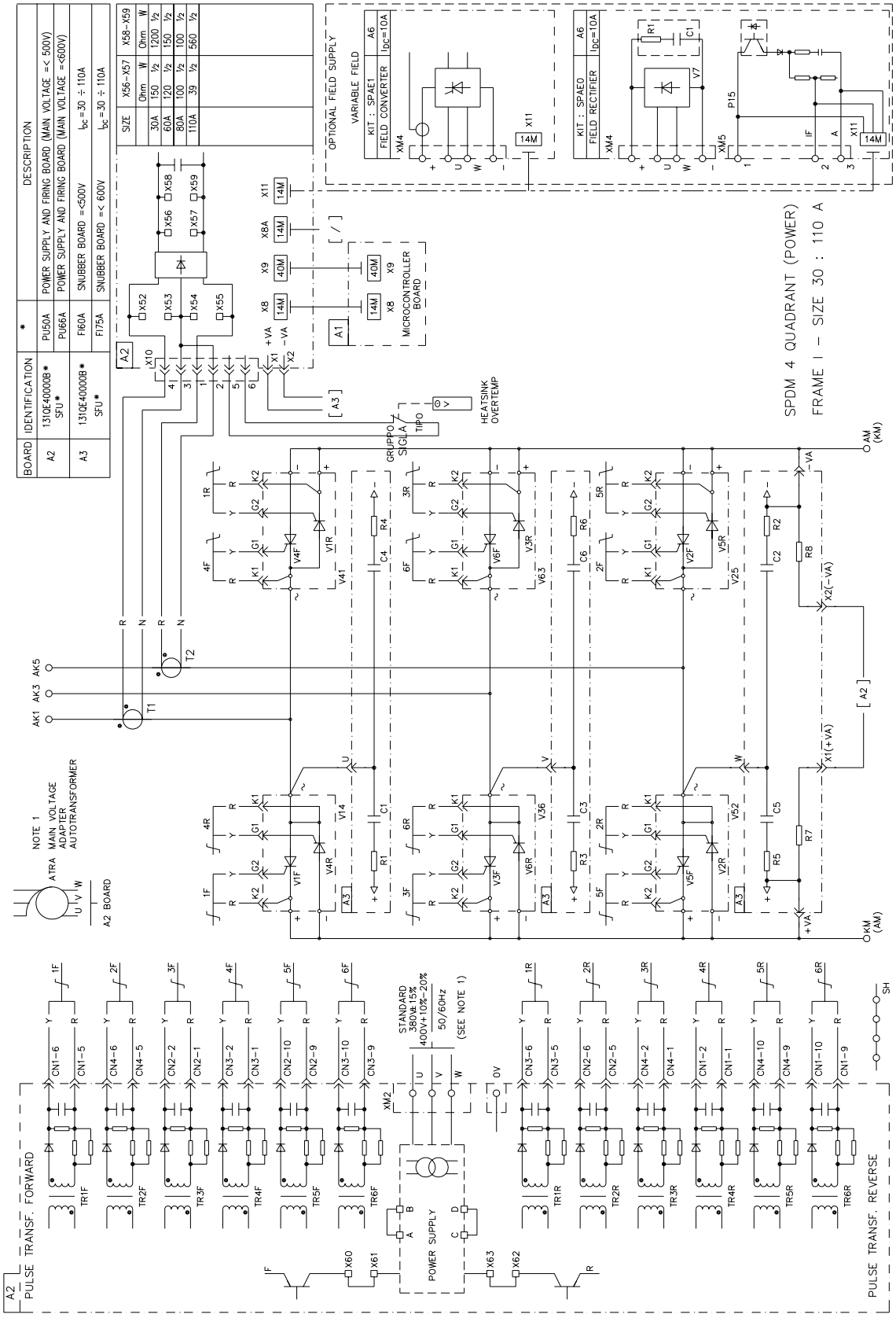
FRAME 1500÷2100A Two quadrant



FRAME 2200A÷4000A U Two quadrant


CIRCUIT DIAGRAM FOR NON REVERSIBLE MODULE
SIZE 2200÷4000A
* = OPTIONAL FOR FUSES MONITORING
NOTE 1
MAIN VOLTAGE ADAPTER AUTOTRASFORMER
A2 BOARD
R7/R8=470KOhm 3W
STANDARD 380/415V 50/60Hz (SEE NOTE 1)
PULSE TRANSF. FORWARD
POWER SUPPLY
*ANALOGIC CONTROLLER BOARD FOR SPAT
MICROCONTROLLER BOARD*
HEATSINK OVERTEMP
TH1-TH2
BLOWER
FREQ. VOLTAGE POWER CURRENT
50Hz 380V 700W 2A
60Hz 440V 700W 2A
BLOWER IDENTIFICATION
50Hz/60Hz 220199
BOARD IDENTIFICATION * DESCRIPTION
A2 131QE40000 BPU50A POWER SUPPLY AND FIRING BOARD (FOR MAIN VOLTAGE ≤600)
BPU66A POWER SUPPLY AND FIRING BOARD (FOR MAIN VOLTAGE 600÷660)
A10/A15 211QS50155B // CONNECTION BOARD
380÷500V SNUBBER R=330ohm-50W C=1uF 1KV (FOR MAIN VOLTAGE ≤500V)
// SEE DD262501 600÷850V SNUBBER R=330ohm-110W C=1uF 1.2KV (FOR MAIN VOLTAGE >500V)
A7 TA1-TA2
C.T. RATIO 3200A/0.5A
COD. 220073

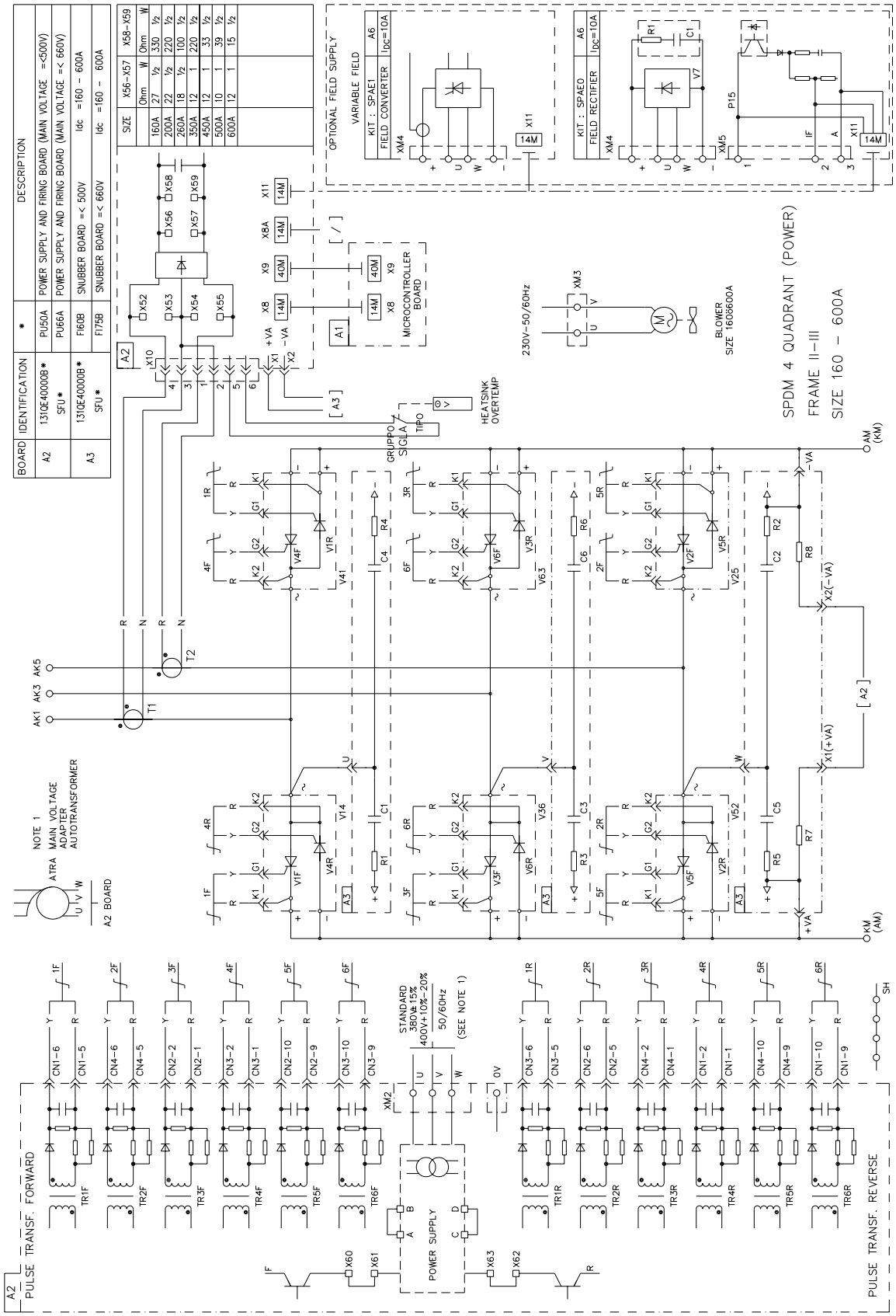
FRAME 30A÷110A Four quadrant



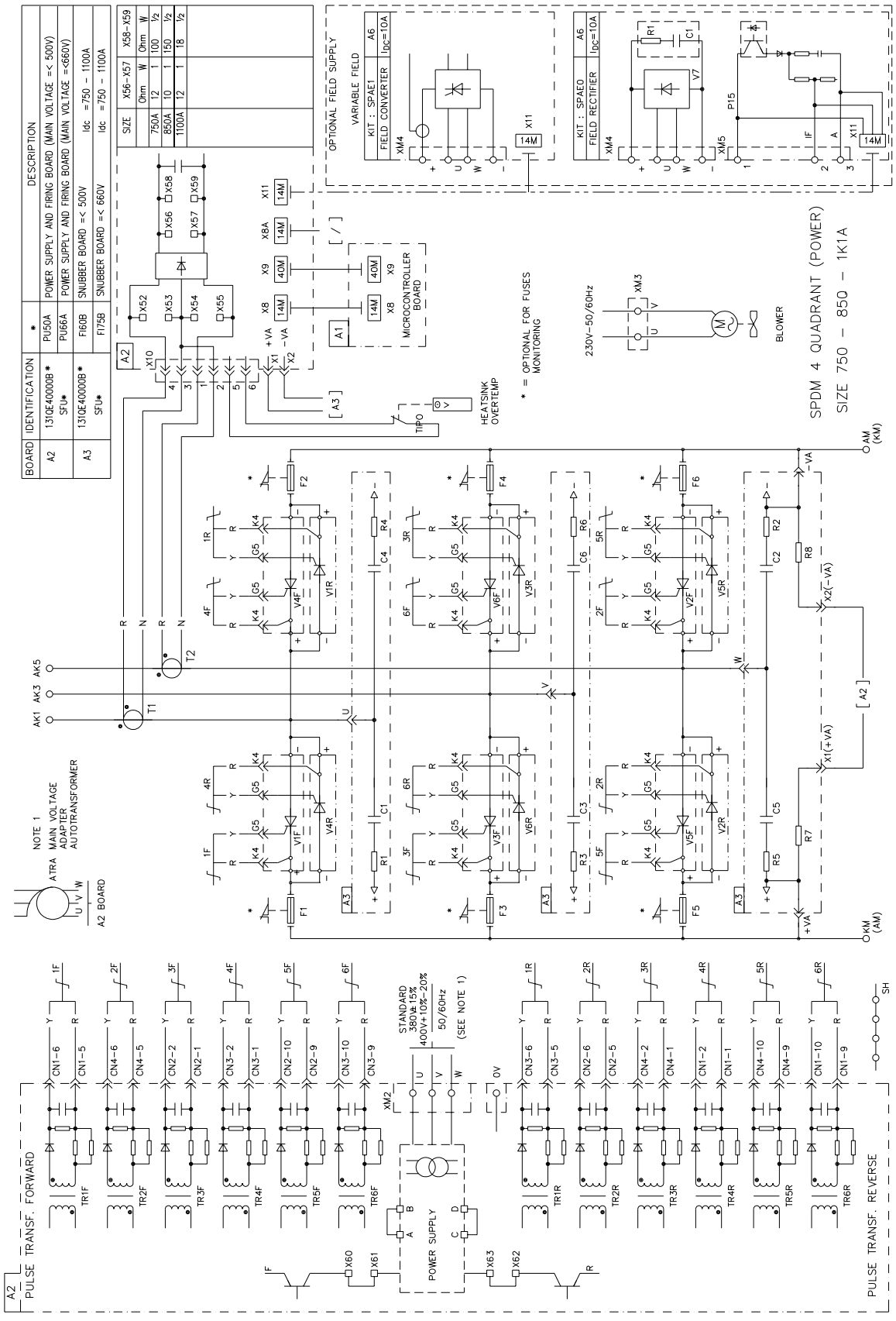
BOARD	IDENTIFICATION	*	DESCRIPTION
A2	1310E40000B * SFU *	PU50A	POWER SUPPLY AND FIRING BOARD (MAIN VOLTAGE =< 500V)
		PU66A	POWER SUPPLY AND FIRING BOARD (MAIN VOLTAGE =<600V)
A3	1310E40000B * SFU *	FI60A	SNUBBER BOARD =<500V I_{DC}=30 ÷ 110A
		FI75A	SNUBBER BOARD =< 600V I_{DC}=30 ÷ 110A

SIZE	X56–X57 Ohm	W	X58–X59 Ohm	W
30A	150	½	1200	½
60A	120	½	150	½
80A	100	½	100	½
110A	39	½	560	½

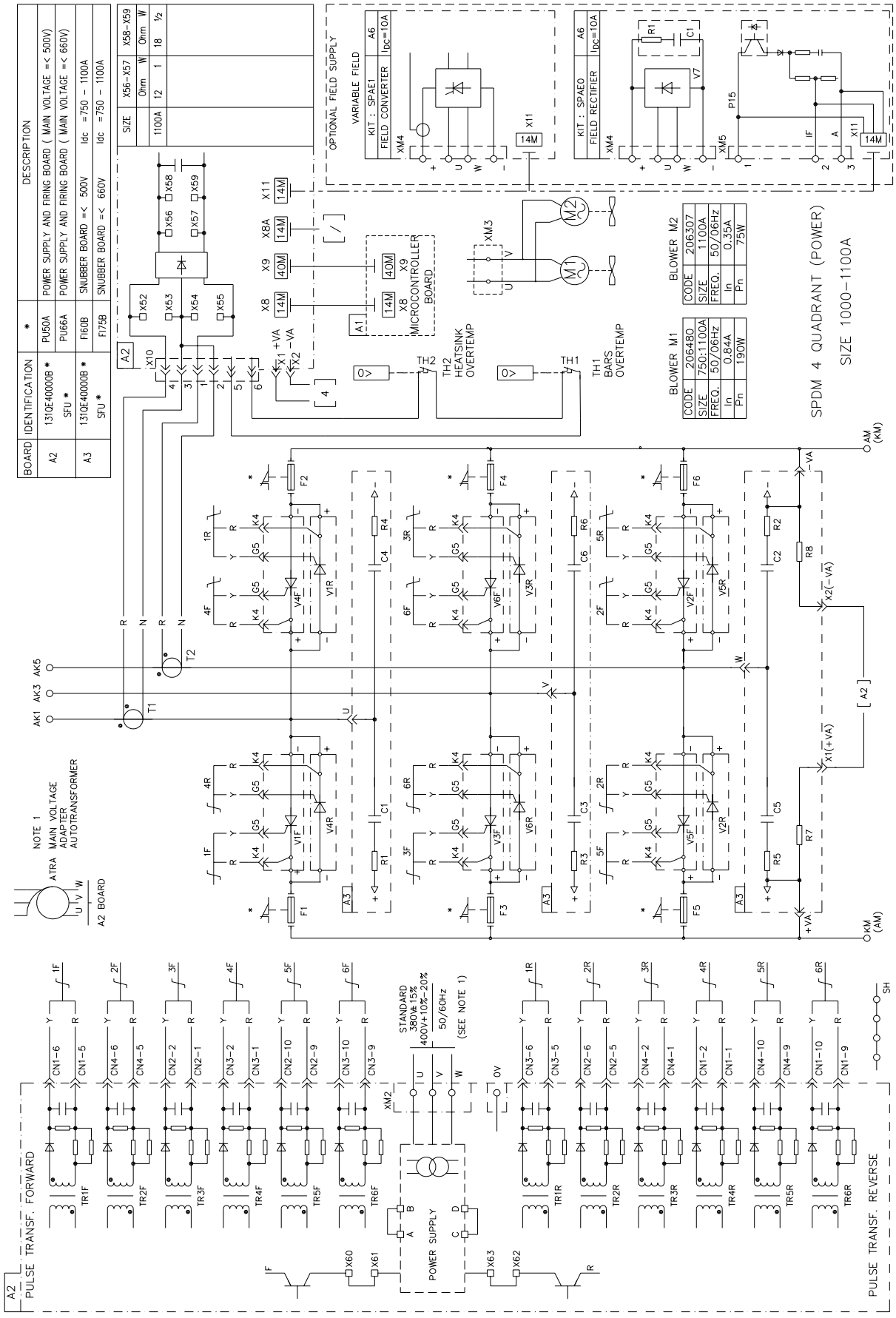
FRAME 160A÷600A Four quadrant



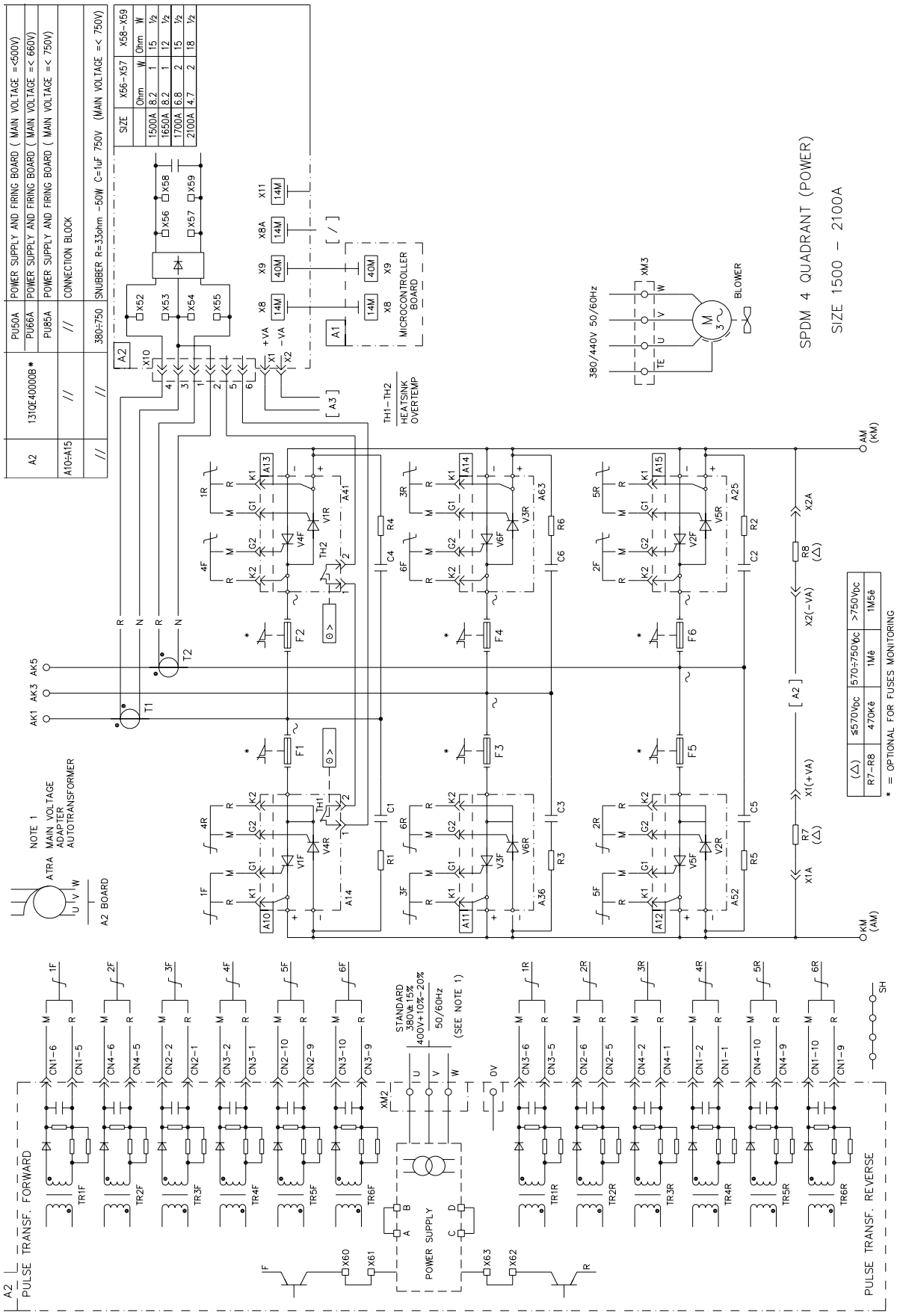
FRAME 750A, 850A, 1100A (SPDM1K1) Four quadrant


SPDM 4 QUADRANT (POWER)
SIZE 750 - 850 - 1K1A
PULSE TRANSF. FORWARD
PULSE TRANSF. REVERSE
POWER SUPPLY
STANDARD 380V±15% 400V+10%-20% 50/60Hz (SEE NOTE 1)
230V-50/60Hz
BLOWER
HEATSINK OVERTEMP
* = OPTIONAL FOR FUSES MONITORING
NOTE 1 MAIN VOLTAGE ADAPTER AUTOTRANSFORMER
MICROCONTROLLER BOARD
OPTIONAL FIELD SUPPLY
VARIABLE FIELD
KIT : SPAE1
FIELD CONVERTER
KIT : SPAE0
FIELD RECTIFIER
BOARD IDENTIFICATION * DESCRIPTION
A2 1310E40000B * PU50A POWER SUPPLY AND FIRING BOARD (MAIN VOLTAGE =< 500V)
SFU* PU66A POWER SUPPLY AND FIRING BOARD (MAIN VOLTAGE =<660V)
A3 1310E40000B * FI60B SNUBBER BOARD =< 500V Idc =750 - 1100A
SFU* FI75B SNUBBER BOARD =< 660V Idc =750 - 1100A
SIZE X56-X57 Ohm W X58-X59 Ohm W
750A 12 1 100 ½
850A 10 1 150 ½
1100A 12 1 18 ½

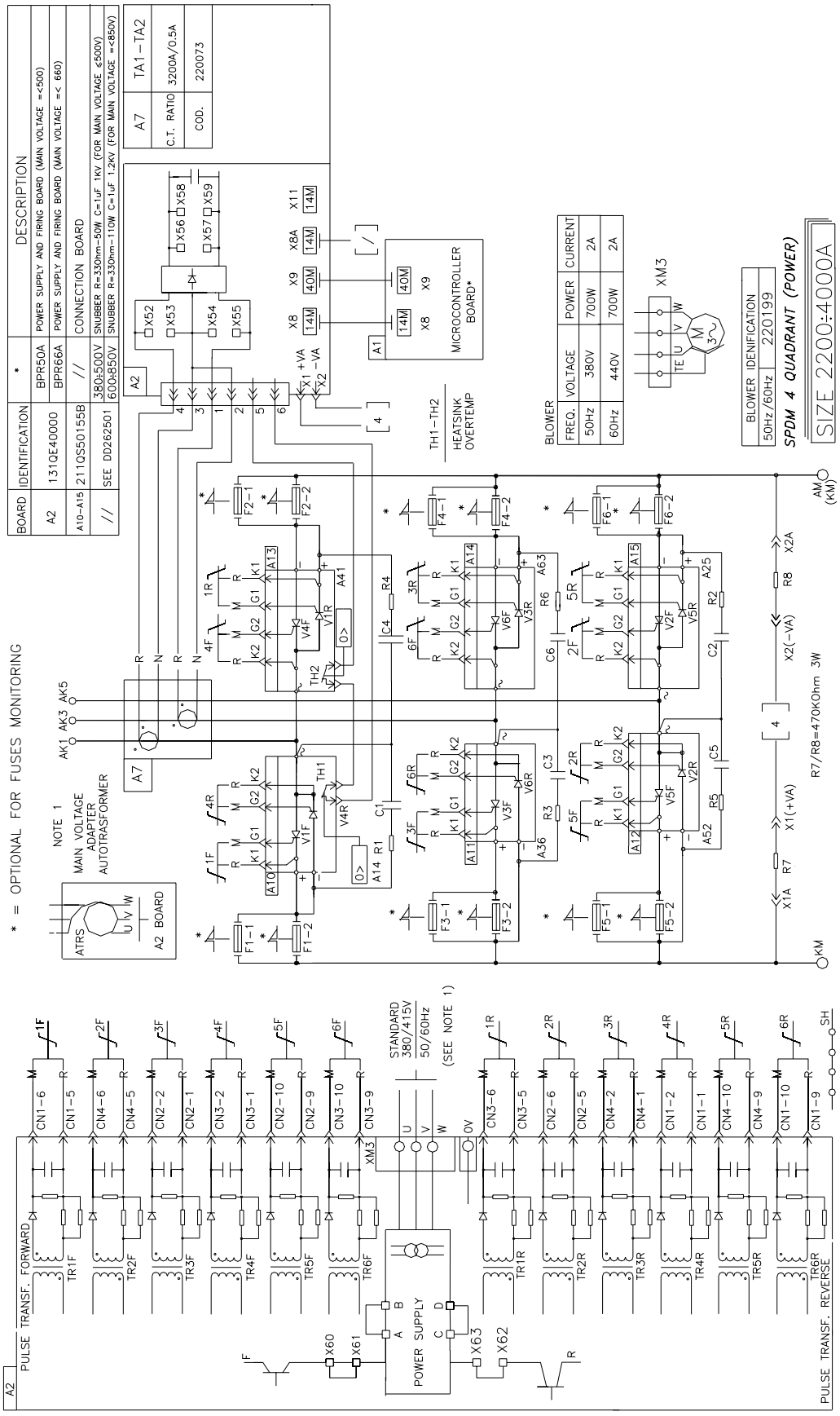
FRAME 1000A-1100A (SPDM1M0-1M1) Four quadrant



FRAME 1500A ÷ 2100A Four quadrant


SPDM 4 QUADRANT (POWER)
SIZE 1500 – 2100A
A2 1310E40000B* PU50A POWER SUPPLY AND FIRING BOARD (MAIN VOLTAGE =<500V)
PU66A POWER SUPPLY AND FIRING BOARD (MAIN VOLTAGE =< 660V)
PU85A POWER SUPPLY AND FIRING BOARD (MAIN VOLTAGE =< 750V)
A10÷A15 // CONNECTION BLOCK
// // 380÷750 SNUBBER R=33ohm -50W C=1uF 750V (MAIN VOLTAGE =< 750V)
SIZE X56–X57 X58–X59
Ohm W Ohm W
1500A 8.2 1 15 ½
1650A 8.2 1 12 ½
1700A 6.8 2 15 ½
2100A 4.7 2 18 ½
NOTE 1 MAIN VOLTAGE ADAPTER AUTOTRANSFORMER
ATRA
A2 BOARD
AK1 AK3 AK5
T1 T2
F1 F2 F3 F4 F5 F6
TH1 TH2
V1R V2R V3R V4R V5R V6R
V1F V2F V3F V4F V5F V6F
A13 A14 A15 A36 A52 A63 A41
C1 C2 C3 C4 C5 C6
R1 R2 R3 R4 R5 R6 R7 R8
A10 A11 A12
K1 K2
G1 G2
1F 2F 3F 4F 5F 6F
1R 2R 3R 4R 5R 6R
X1 X2 X10
+VA -VA
X52 X53 X54 X55 X56 X57 X58 X59
X8 X8A X9 X11
14M 40M
A1 MICROCONTROLLER BOARD
A3
TH1–TH2 HEATSINK OVERTEMP
380/440V 50/60Hz
XM3
BLOWER
AM (KM)
KM (AM)
X1A X1(+VA) X2(–VA) X2A
(Δ) R7–R8 ≤570Vpc 470KΩ 570÷750Vpc 1MΩ >750Vpc 1MΩ
* = OPTIONAL FOR FUSES MONITORING
PULSE TRANSF. FORWARD
PULSE TRANSF. REVERSE
TR1F TR2F TR3F TR4F TR5F TR6F
TR1R TR2R TR3R TR4R TR5R TR6R
CN1–6 CN1–5 CN4–6 CN4–5 CN2–2 CN2–1 CN3–2 CN3–1 CN2–10 CN2–9 CN3–10 CN3–9
CN3–6 CN3–5 CN2–6 CN2–5 CN4–2 CN4–1 CN1–2 CN1–1 CN4–10 CN4–9 CN1–10 CN1–9
XM2
STANDARD 380Vac±15% 400V+10%–20% 50/60Hz (SEE NOTE 1)
U V W 0V
POWER SUPPLY
A B C D
X60 X61 X62 X63
F R
SH

FRAME 2200A ÷ 4000A Four quadrant


SIZE 2200÷4000A
SPDM 4 QUADRANT (POWER)
* = OPTIONAL FOR FUSES MONITORING
NOTE 1
MAIN VOLTAGE ADAPTER AUTOTRASFORMER
A2 BOARD
ATRS
PULSE TRANSF. FORWARD
PULSE TRANSF. REVERSE
POWER SUPPLY
STANDARD 380/415V 50/60Hz
(SEE NOTE 1)
MICROCONTROLLER BOARD*
HEATSINK OVERTEMP
TH1-TH2
BLOWER
BLOWER IDENIFICATION
50Hz/60Hz 220199
R7/R8=470KOhm 3W
BOARD | IDENTIFICATION | * | DESCRIPTION
A2 | 131QE40000 | BPR50A | POWER SUPPLY AND FIRING BOARD (MAIN VOLTAGE =<500)
 | | BPR66A | POWER SUPPLY AND FIRING BOARD (MAIN VOLTAGE =< 660)
A10÷A15 | 211QS50155B | // | CONNECTION BOARD
// | SEE DD262501 | 380÷500V | SNUBBER R=330hm-50W C=1uF 1KV (FOR MAIN VOLTAGE ≤500V)
 | | 600÷850V | SNUBBER R=330hm-110W C=1uF 1.2KV (FOR MAIN VOLTAGE =<850V)
A7 TA1-TA2
C.T. RATIO 3200A/0.5A
COD. 220073
FREQ. VOLTAGE POWER CURRENT
50Hz 380V 700W 2A
60Hz 440V 700W 2A

A7 CONNECTIONS

A7.1 Terminal blocks

Note: U.I. means User Interface panel SPDI 1

7.1.1 Terminal blocks XM1 (C board)	
Terminal	Description
1-2	N.O. contact of relay K1 220 V 2A. Closed contact = motor running
3-4	N.O. contact of relay K2 220 V 2 A. Closed contact = converter ready; the relay, normally energized, will be de-energized at the intervention of any internal protections.
5	Encoder power supply. If jumper JP26 is in 2-3 position (Encoder Push-Pull power supply), terminal 5 has +24 V 100 mA output voltage coming from the power supply unit connected to terminals 22 and 23. If jumper JP26 is in 1-2 position (Encoder Line-Driver power supply) terminal 5 is disabled and the encoder must be fed from the outside with 5 ÷ 24 V voltage.
6	U1 signal input from encoder; Rin = 10 KΩ (maximun frequence 50 KHz).
7	$\overline{U1}$ signal input from differential encoder, otherwise not used; Rin = 10 K (maximun frequence = 50KHz).
8	U2 signal input from encoder; Rin = 10 KΩ (maximun frequence 50 KHz).
9	$\overline{U2}$ signal input from differential encoder, otherewise not used; Rin =10 KΩ (maximun frequence = 50KHz).
10	U3 signal input from encoder (turn pulse). If used remove jumper J23. Rin = 10 KΩ (maximun frequence = 50KHz).
11	$\overline{U3}$ signal input from differential encoder, otherewise not used. Rin = 10 KΩ (maximun frequence = 50KHz). Note: the final position signal can come from an external transducer which drives a N.O. or N.C. contact. Connect the N.O. contact to terminals XM1-10 - XM1-5 and place jumper J23 on position 1-2; alternatively connect the N.C. contact to terminals XM1-10 – XM1-12 and place jumper J23 on position 2-3.
12	0 V encoder common point; it is galvanically insulated from the 0V control common, terminals 27, 31, 36, 38, 41.
13	START logic input;it enables the converter when connected to terminal 23. Optocoupled input,8mA current consumption.
14	RAMP logic input;it enables the ramp after the speed reference when connected to terminal 23 (enter the ramp parameters through the user interface). Optocoupled input,8mA current consumption.
15	INTRF1 logic input (iog); when connected to terminal 23, it replaces the external speed reference with the internal reference n.1; if par. CDE = OFF the INTRF1 acts as START input also; if par. CDE = 0N the START is not enabled. (Enter the reference value through the user interface; see parameters TC7 and TD7). Optocupled input, 8mA current consumption.
16	INTRF2 logic input (jog); when connected to terminal 23, it replaces the external speed reference with the internal reference n. 2; if par. CDE = OFF the INTRF2 acts as START input also; if par. CDE=ON, the START is not enabled (Enter the reference value through the user interface). Optocoupled input, 8mA current consumption.
17-18-19	COM1, COM2, COM3 programmable logic inputs; when connected to terminal 23, the function selected through U.I. will be enabled. Optocoupled inputs, 8mA current consumption.
20	KP logic input, normally connected to terminal 23; removing this connection the converter will be disabled but the relay K2 will not be de-energized. It is used to disable the converter at the intervention of an external protection. Optocoupled, 8 mA current consumption.
21	REMOTE RESET logic input; when connected to terminal 23 the microcontroller will be reset. It is parallel connected to the reset local pushbutton on C board. Optocoupled, 8 mA current consumption.
22-23	These terminals must be connected to an external power source (24V/500 mA) needed to supply the encoder Push-Pull circuits and the logic input and output circuits, with galvanic isolation from the control circuits. Terminal 22 = common Terminal 23 = +24 V
24	OUT1 24V/50 mA logic output. It is programmable through the parameter DO1. Optocoupled, close the load path to terminal 22.
25	OUT2 24V/50 mA logic output. It is programmable through the parameter DO2. Optocoupled, close the load path to terminal 22.
26	TACH tacho generator input (if encoder is not used).Resolution = 10 bit + sign. Insert appropriate jumper according to the max tacho voltage value: (Enter through U.I. the max speed value; see parameter DB5).

jumper					
12	If	0V	< Vt <	10V	Rin = 10KΩ
11		11V	< Vt <	19V	Rin = 20KΩ
10		20V	< Vt <	36V	Rin = 38KΩ
9		20V	< Vt <	69V	Rin = 71KΩ
8		70V	< Vt <	131V	Rin = 139KΩ
--		132V	< Vt <	250V	Rin = 251KΩ

Terminal	Description
27	0V control common terminal.
28	±10V If analog input, Rin = 50 KΩ, Resolution = 9 bits + sign. It is used as input of the motor excitation current when an external exciter is used. Place jumper 25 on pins 1-2. If the internal exciter (SPAE1) is used, terminal 28 should be disconnected and jumper 25 should be placed on pins 2-3 so the internal circuit is used to measure the motor excitation current.
29	±10V Ean 1 programmable analog input. Rin = 50 K, Resolution = 9 bits + sign.
30	±10V Ean 2 programmable analog input. Rin = 50 K, , Resolution = 9 bits + sign.
31	0V common terminal of control circuits.
32	±10V Varm analog input, Rin = 50 KΩ, Resolution = 9 bits + sign; reserved to the armature voltage signal provided by external transducer.ichiede, (place jumper 7 on pins 1-2). Normally the signal is provided by internal high impedance transducer; in this case insert jumper 7 between pins 2-3. Terminal 32 should be disconnected. Also insert the jumper according to the nominal armature voltage: jumper 15 if 160V < Va <300V 16 300V < Va <570V 17 570V < Va <900V (Enter through U.I. the nominal voltage value).
33 – 34	±10V RIF programmable differential analog input, differential Rin = 100 KΩ, Resolution = 10 bits + sign. If the input signal is 0-20mA current type, insert jumper 13; the differential Rin will be decreased to 500Ω. Terminal 34 = inverting input, terminal 33 = non-inverting input.
35	Analog output for armature current measurements instrument. Place jumper JP14 on pins 1-2 if the used instrument is a milliamperometer (5 mA max output current). Place jumper JP14 on pins 2-3 if the used instrument is a voltmeter (±10V max output voltage). Place jumper JP22 on pins 2-3 if the instrument is central zero type (value and sign measurements). Place jumper JP22 if the instrument is lateral zero type (absolute value measurements). Close the load path to terminal XM1-36. The output is adjustable with PR2 trimmer (see paragr.C-2-9). See Ia_monitor description, par. 2.4.1 section C.
36	0V common terminal of control circuits.
37	±10V or 5 mA PWM1 programmable analog output, Resolution = 8 bits + sign. Close the load path to terminal 38. Place jumper JP27 on pins 2-3 for a V output (±10V full scale); Place jumper JP27 on pins 1-2 for a mA output (±5 mA full scale).
38	0V common terminal of control circuits.
39	±10V or 5 mA PWM2 programmable analog output, Resolution = 8 bits + sign. Close the load path to terminal 41. Place jumper JP24 on pins 2-3 for a V output (±10V full scale); Place jumper JP24 on pins 1-2 for a mA output (±5 mA full scale). With external exciter (weakened field operation), the output is reserved to the reference If_0 signal of the motor excitation current.
40	±10V or 5 mA PWM3 programmable analog output, Resolution = 8 bits + sign. Close the load path to terminal 41. Place jumper JP18 on pins 2-3 for a V output (±10V full scale); Place jumper JP18 on pins 1-2 for a mA output (±5 mA full scale). PWM3 is programmable for motor speed measurement instrument; see N_monitor description, par. 2.4.2 section C.
41	0V common terminal of control circuits.
42	10V output (5 mA max.). Used to supply the reference potentiometer.

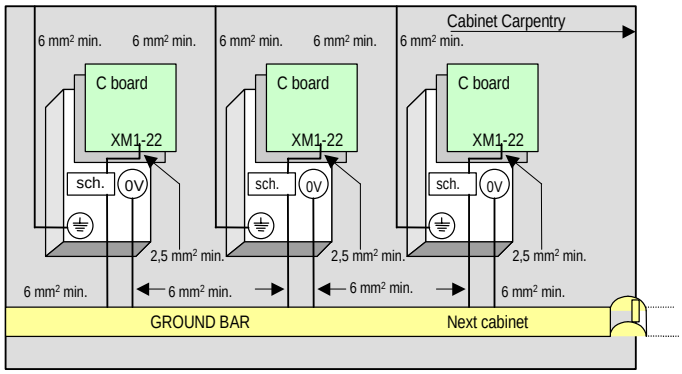
7.1.2 Terminal blocks XM2 (P board)	
U – V – W	Electronic power supply input; 380 V three phase voltage, 30 VA. Note: for proper operation of the electronic circuits, the voltages applied to terminals U – V – W must have the same phase correspondence of the voltages applied to power terminals AK1 – AK3 – AK5.

7.1.3 Terminal blocks XM3 (blower)		
U - V	(Single phase)	Input for blower supply (no blower for size I); see) par. 3, TECHNICAL DATA, notes (2), (3), (4) and par.7.6. Suggested diagrams.
U - V - W	(Three phase)	

A7.2 Ground connections

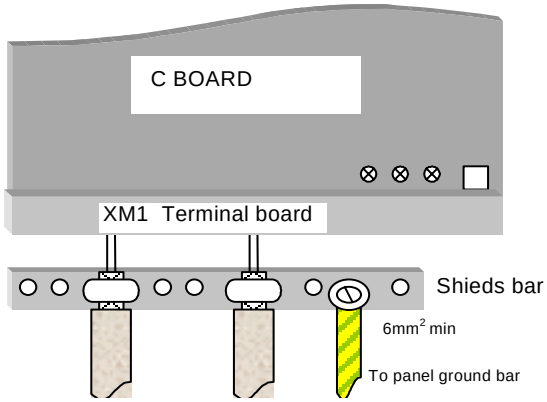
The proper execution of the ground connections allows a high immunity to noise and guarantees that 0 V levels be constantly fixed to ground.

Equipment and cabinet metal parts must be connected among them and to the ground circuit with good contact surfaces, to ensure proper high frequency conductivity. Galvanized bottom plates are the best solution; in case of coated surfaces, remove the coat in the connection area or use abrasive washers. Grounding must be carried out using short, high-frequency cables (flat plaited wires with great section). These must be connected to collector ground bars, which are grounded to a single point ("Y" connection).

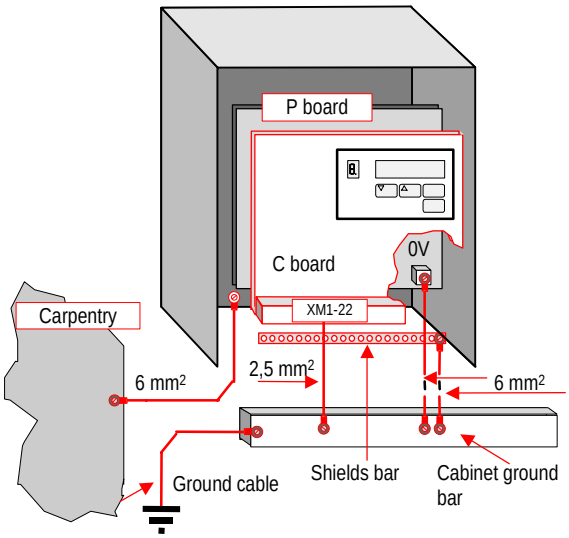


- Connections to the cabinet carpentry:
size I:
connect the proper little bolt on the heatsink to the cabinet carpentry, by a wire having 6 mm2 section minimun. The path must be the shortest one.
size II, III, IIIL, IIILL:
the connection is made by one of the fastening brackes duly marked; the connection must guarantee a good contact.
size IV, V:
the connection is made by the fastening screws of the cabinet; the connection must guarantee a good contact.

Shields bar:
it must be connected to the cabinet ground bar by a wire having 6 mm2 section minimum.
The path must be the shortest one.
All signals must be properly shielded. The wire shields must be connected to the shields bar; at the other end of the wire, the shields must never be connected.



- Terminal 0 V:
it must be connected to the ground bar by a wire having 6 mm2 section minimum. As an example, valid in most cases, this terminal may be connected to the shield bar by a wire having 2 mm2 section minimum.
- Terminal XM1-22:
(common of the +24 V external power supply); it must be connected to the shield bar by a wire having 2 mm2 section minimum.



A7.3 Recommended fuses type

2 Quadrant	Mains Voltage	AC Fuses (690V) 3 Pieces
SPDM030UG	400V	ELC20653301
SPDM030UG	500V	ELC20653301
SPDM030UH	600V	ELC20653301
SPDM600UG	400V	ELC20653302
SPDM600UG	500V	ELC20653302
SPDM600UH	600V	ELC20653302
SPDM080UG	400V	ELC20653303
SPDM080UG	500V	ELC20653303
SPDM080UH	600V	ELC20653303
SPDM110UG	400V	ELC20653304
SPDM110UG	500V	ELC20653304
SPDM110UH	600V	ELC20653304
SPDM160UG	400V	ELC20653306
SPDM160UG	500V	ELC20653306
SPDM160UH	600V	ELC20653306
SPDM200UG	400V	ELC21242801
SPDM200UG	500V	ELC21242801
SPDM200UH	600V	ELC21242801
SPDM260UG	400V	ELC21242802
SPDM260UG	500V	ELC21242802
SPDM260UH	600V	ELC21242802
SPDM350UG	400V	ELC21242803
SPDM350UG	500V	ELC21242803
SPDM350UH	600V	ELC21242803
SPDM450UG	400V	ELC21242804
SPDM450UG	500V	ELC21242804
SPDM350UH	600V	ELC21242804
SPDM500UK	690V	ELC21242805
SPDM600UG	400V	ELC21242806
SPDM600UG	500V	ELC21242806
SPDM600UH	600V	ELC21242806

4 Quadrant	Mains Voltage	AC Fuses * 3 Pieces	DC Fuses *	Q.ty
SPDM030RG	400V	ELC20653301	ELC20653301	1
SPDM030RG	500V	ELC20653401	ELC20653401	2
SPDM030RH	600V	ELC20653401	ELC20653401	2
SPDM060RG	400V	ELC20653302	ELC20653303	1
SPDM060RG	500V	ELC20653402	ELC20653403	2
SPDM060RH	600V	ELC20653402	ELC20653403	2
SPDM080RG	400V	ELC20653303	ELC20653304	1
SPDM080RG	500V	ELC20653403	ELC20653404	2
SPDM080RH	600V	ELC20653403	ELC20653404	2
SPDM110RG	400V	ELC20653304	ELC20653305	1
SPDM110RG	500V	ELC20653404	ELC20653405	2
SPDM110RH	600V	ELC20653404	ELC20653405	2
SPDM160RG	400V	ELC20653306	ELC21242801	1
SPDM160RG	500V	ELC20653406	ELC21242901	2
SPDM160RH	600V	ELC20653406	ELC21242901	2
SPDM200RG	400V	ELC21242801	ELC21242801	1
SPDM200RG	500V	ELC21242901	ELC21242901	2
SPDM200RH	600V	ELC21242901	ELC21242901	2
SPDM260RG	400V	ELC21242802	ELC21242803	1
SPDM260RG	500V	1000094223	ELP21242903	2
SPDM260RH	600V	1000094223	ELP21242903	2
SPDM350RG	400V	ELC21242803	ELC21242804	1
SPDM350RG	500V	ELP21242903	ELC407417	2
SPDM350RH	600V	ELP21242903	ELC407417	2
SPDM450RG	400V	ELC21242804	ELC21242805	1
SPDM450RG	500	ELC40803808	ELC40803804	2
SPDM350RH	600V	ELC40803808	ELC40803804	2
SPDM500RK	690V	ELC40803803	ELC40803804	2
SPDM600RG	400V	ELC21242806	ELC21242807	1
SPDM600RG	500V	ELC40803804	ELC40803806	2
SPDM600RH	600V	ELC40803804	ELC40803806	2

*	690 V	1000 V

Note: Sizes IIIL, IIILL, IV and V have 6 fuses placed inside the converter.

Note: The fuses fail signalling microinterruptor type depends on the fuses type used:

MICROINTERRUPTOR		FUSES TYPE
TYPE	MANUFACTURER	
170H0235	BUSSMANN	T
170H0068	BUSSMANN	K
MC3E1-S	FERRAZ	K
170H0069	BUSSMANN	K
MC3E2-5	FERRAZ	K

A7.4 Line reactors

The three phase supply line of the converter should have in series with any phase an equivalent reactance whose voltage drop at the nominal phase current (I_{LN}=0,82 I_N) has a value in the range 2-4% of the phase voltage; this value includes all existing reactances, including the line and possible transformer. If the equivalent reactance will be insufficient, an additional reactance should be provided (1 three phase type or 3 single phase type), with value equal to the difference between the shown value and the total existing one.
Plate current flowing in the additional reactance: $I_{LN} = 0.82 * I_N$

where I_N = Silcopac D converter nominal current or, if known, the RMS value of the permanently delivered current.

NOTE: In order for the converter to operate properly, an optimum power supply system must be provided for, installing suitable protections to prevent operating overvoltages from reaching values which could be dangerous for the converter.

$$U_K = \frac{0{,}82x\sqrt{3}x2x\pi xfxL_I I_N}{U_N}$$

IN =motor rated current
F =power supplì frequency
UN =ratef voltage power supply
LI =reactor inductance

THREE-PHASE REACTORS

Rated Current (40°C)	Phase Inductance	Losses	Code	Dimensions			Weight
				L	P	H	
A	µH	W		mm			Kg
16	1300	35	22386201	150	95	185	5
20	1000	45	22386202	150	95	185	5,5
30	750	70	22386203	150	115	185	7
50	450	125	22386204	210	135	182	10,5
65	340	145	22386205	210	135	182	10,5
90	240	160	22386206	210	152	182	15
120	190	180	22386207	255	168	195	16
170	130	210	22386208	255	174	195	18
220	100	250	22386209	255	174	255	20
270	82	365	22386210	255	182	255	21
360	60	405	22386211	300	200	360	36
420	53	490	22386212	300	210	360	40
500	44	365	22386213	300	220	360	50
620	36	405	22386214	300	225	360	55
690	33	490	22386215	360	217	400	65
720	31	525	22386216	360	217	400	65
850	26	585	22386217	360	230	400	70
1000	22	910	22386218	360	285	450	96
1200	18	965	22386219	440	280	555	115
1340	17	1015	22386220	440	280	555	150
1540	15	1225	22386221	440	315	555	200
1700	11	1030	22386222	440	280	555	190
1800	9	1120	22386223	440	280	555	190
2100	8	1790	22386224	440	360	570	200

With temperature higher than 40°C decrease rated current by 0,8% for °C.
The reactors in the table are suitable for 380-690V power supply. The percentage voltage drop is function of the power supply voltage.

We suggest to use an individual transformer if the converters power supply is greater than 690V or the drive rated current is greater than 2000A.

Note: See Appendix E

A7.5 Encoder Selection

The Silcopac D converter is able to acquire the speed feedback using the signals coming from an Encoder installed on motor shaft.
It is possible to use a large range of Encoder types available on the market selecting between Encoders with the following characteristics:

Electronic output stage:	Push-Pull	Line Driver
Power supply voltage:	+24 V	5÷24 V

On the XM1 terminal block (terminal from XM1-5 to XM1-12) are available all the terminals required to connect the Encoder channels with or without zero signal differential or non differential.

The number of pulses per revolution (p.p.r.) must be choosen considering the maximum speed (the frequence must be in the range from 7 Hz to 50 KHz).

$F(hz) = (p.p.r.) \cdot \frac{N_{MAX}}{60}$		where F(hz) = pulse frequency (< 50 Khz), NMAX = maximum r.p.m..
Example:	NMax = 3000 rpm	Pulse per revolution = 1000 F = 1000 x 3000 / 60 = 50kHz

When the frequence is lower than 7 Hz the converter shows speed = 0.
When the frequence is higher than 50 KHz then converter is not able to acquire the correct speed feedback information.

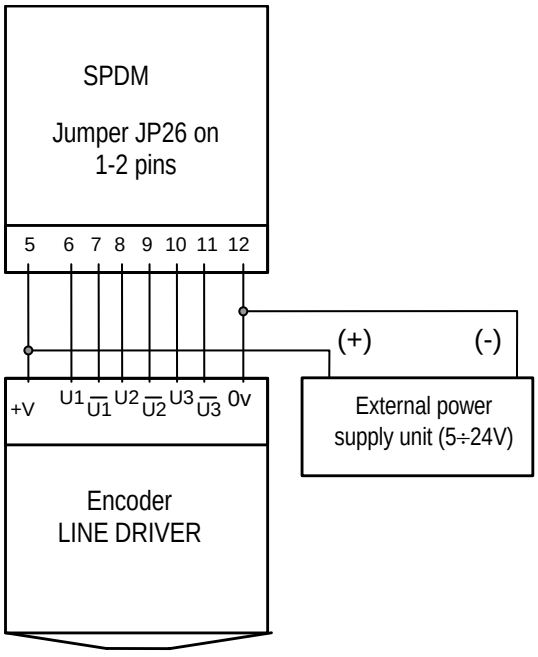
In the applications using the "Positioning function" the resolution (minimum measurable error) is calculated starting from the pulses per revolution.

$$Resolution = \frac{360^{o} \cdot N_{MAXmotor}}{(p.p.r.) \cdot N_{MAXdownstreamreducer}}$$, expressed in degrees.

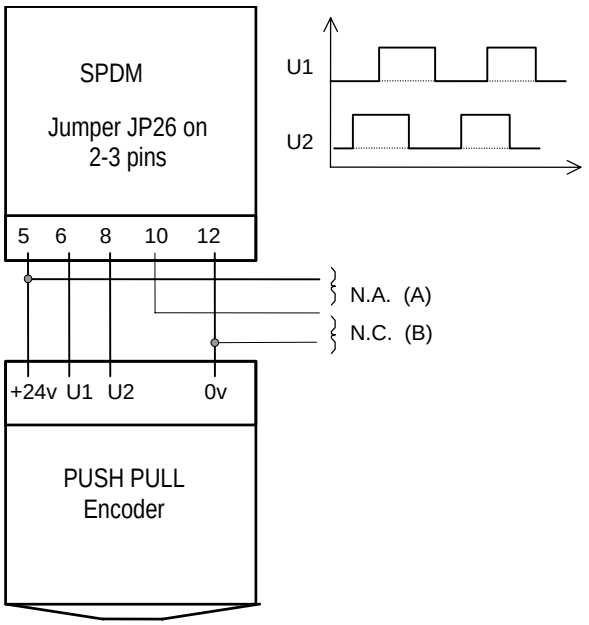
if, for exemple, the speed reducer has a ratio = 1/2, the resolution after the speed reducer is double than that on the motor shaft.
It is possible to use Encoders that have a max number of pulse per revolution equal to 9999.

CONNECTIONS:

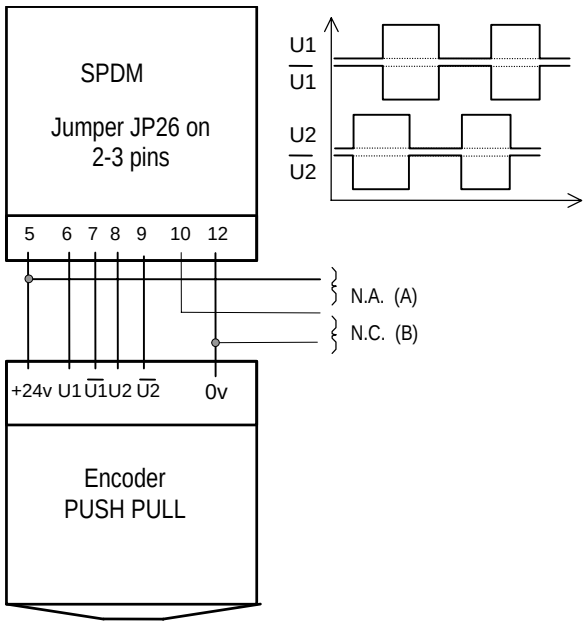
“Line driver” three channel Encoder



Non differential two channel Encoder



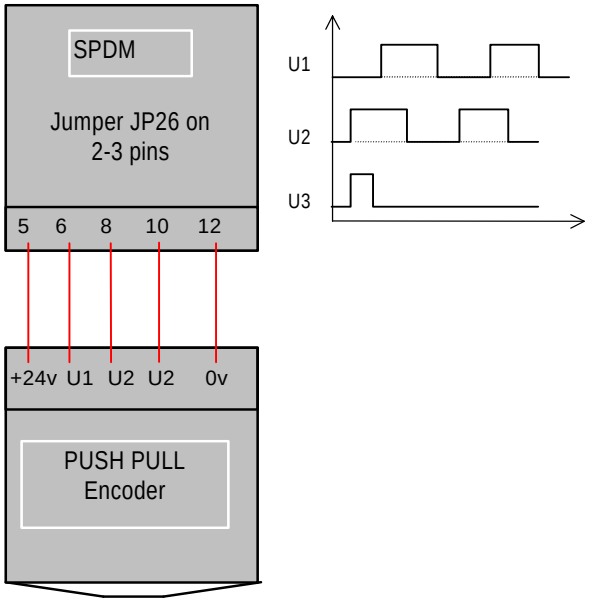
Differential two channel Encoder



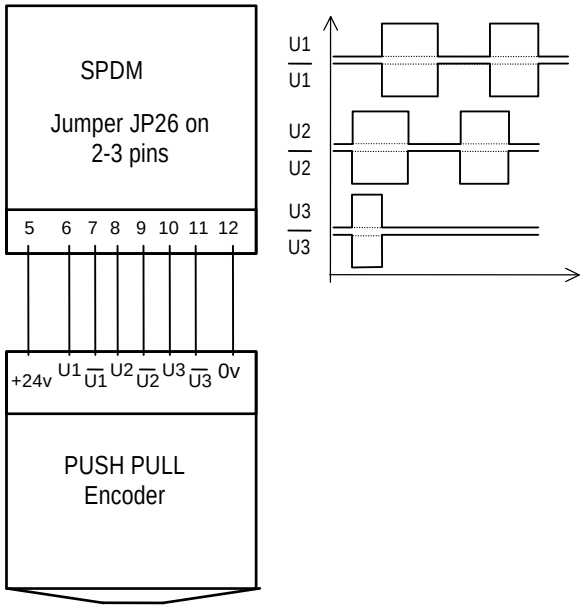
The zero pulse, if necessary, may be acquired using a normally open contact (selection A) or a normally close contact (selection B).

Selection (A): Jumper JP23 Open (See par. 7.1.1).
Selection (B): Jumper JP23 Close (See par. 7.1.1).

Non differential three channel Encoder (with zero pulse)

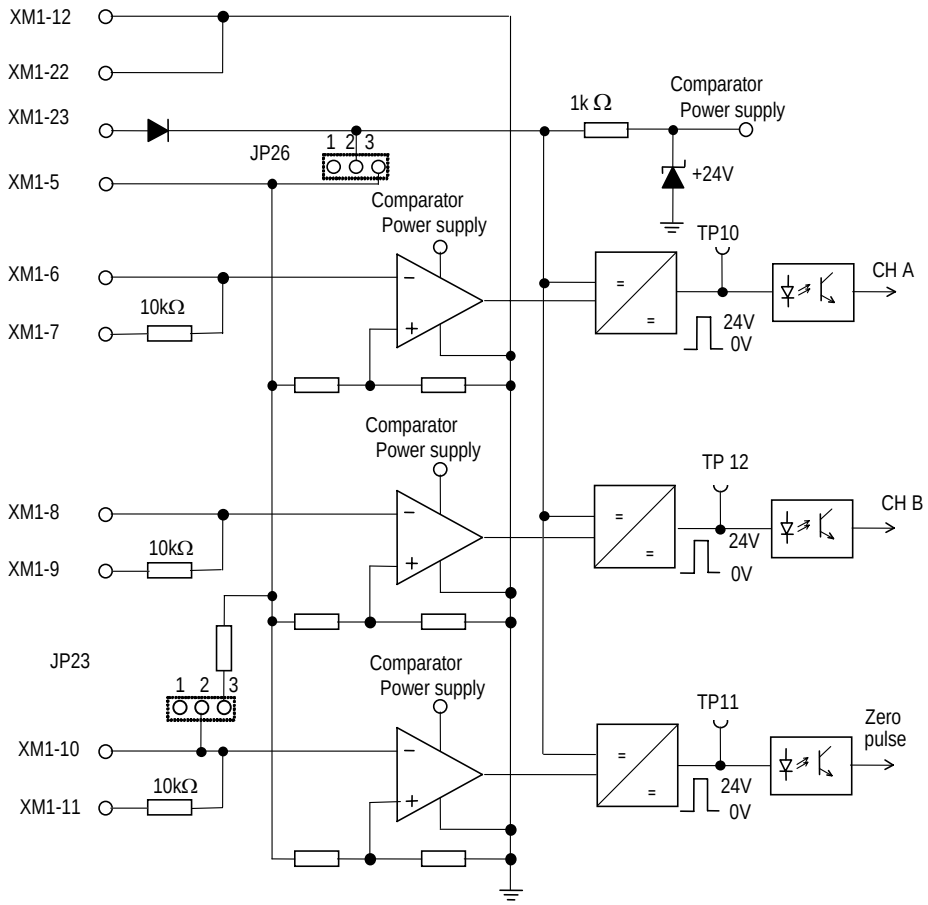


Differential three channel Encoder (with zero pulse)



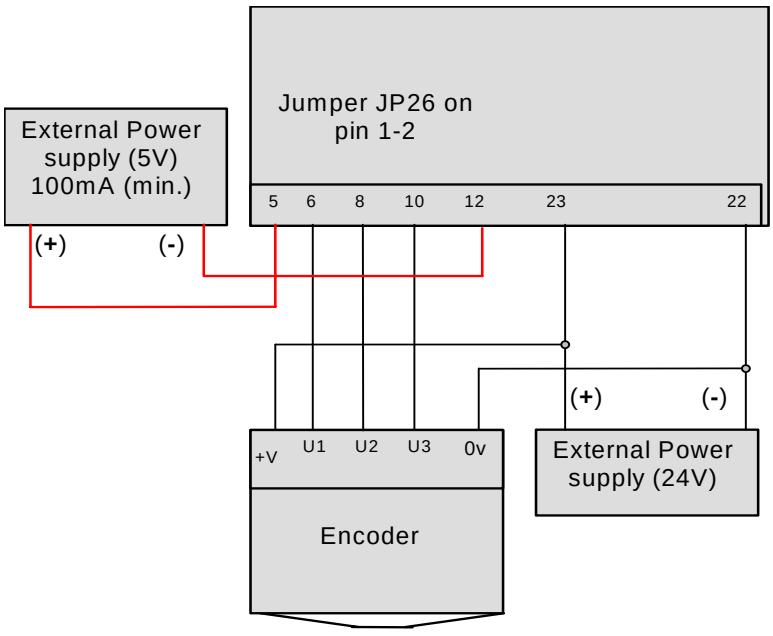
Encoder controlled from workshop with 1000 p.p.r.
Code 20651902

ATTENTION ! If the encoder pulse value is different from power supply value, it is necessary to open the jumper JP26 (or to change the position on 1-2) and to apply on terminal XM1-5 a voltage signal with the same value of pulses. The following picture represents the SPDM input circuit for the detection and the squaring of the encoder pulses.



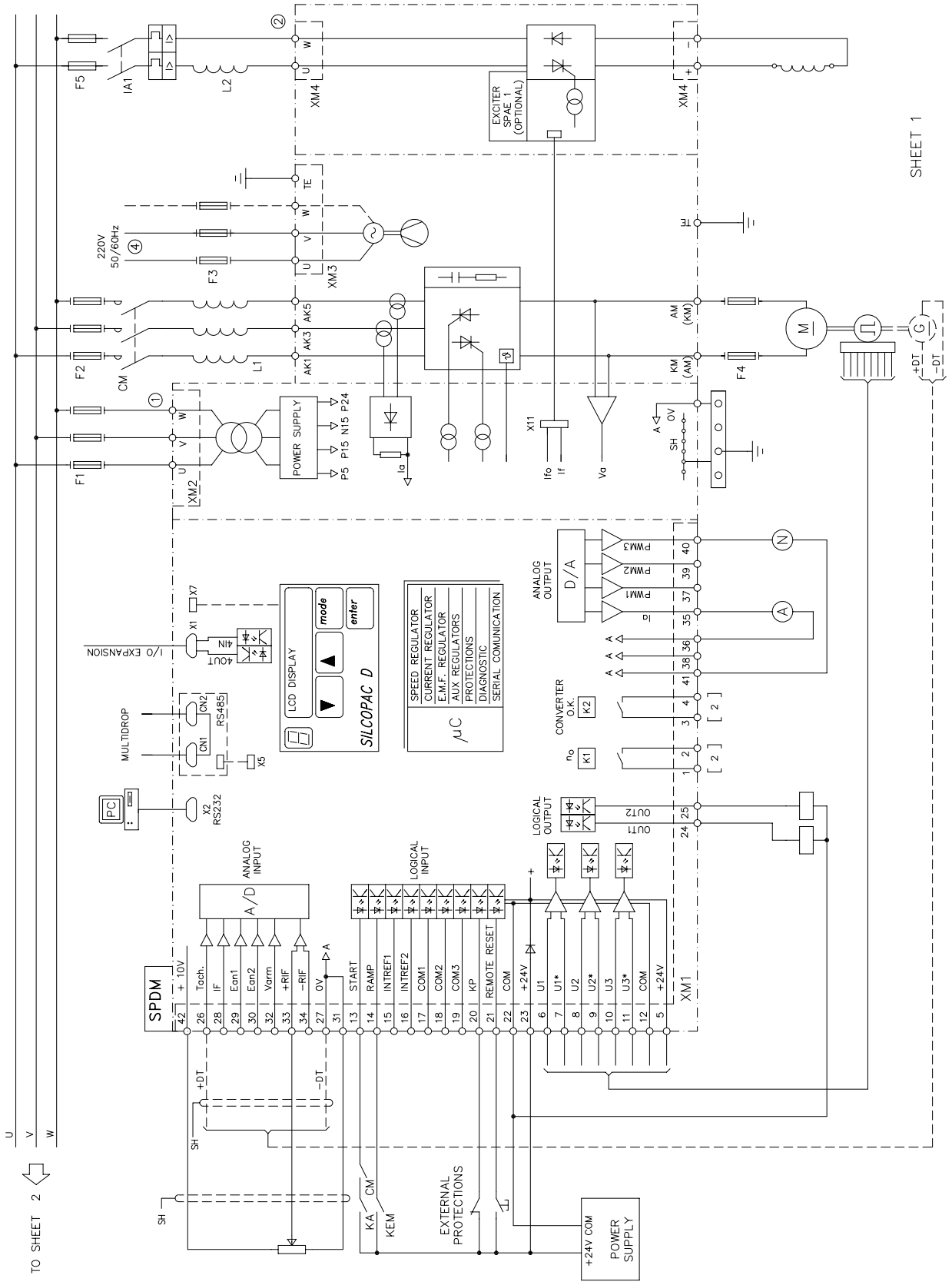
Exemple

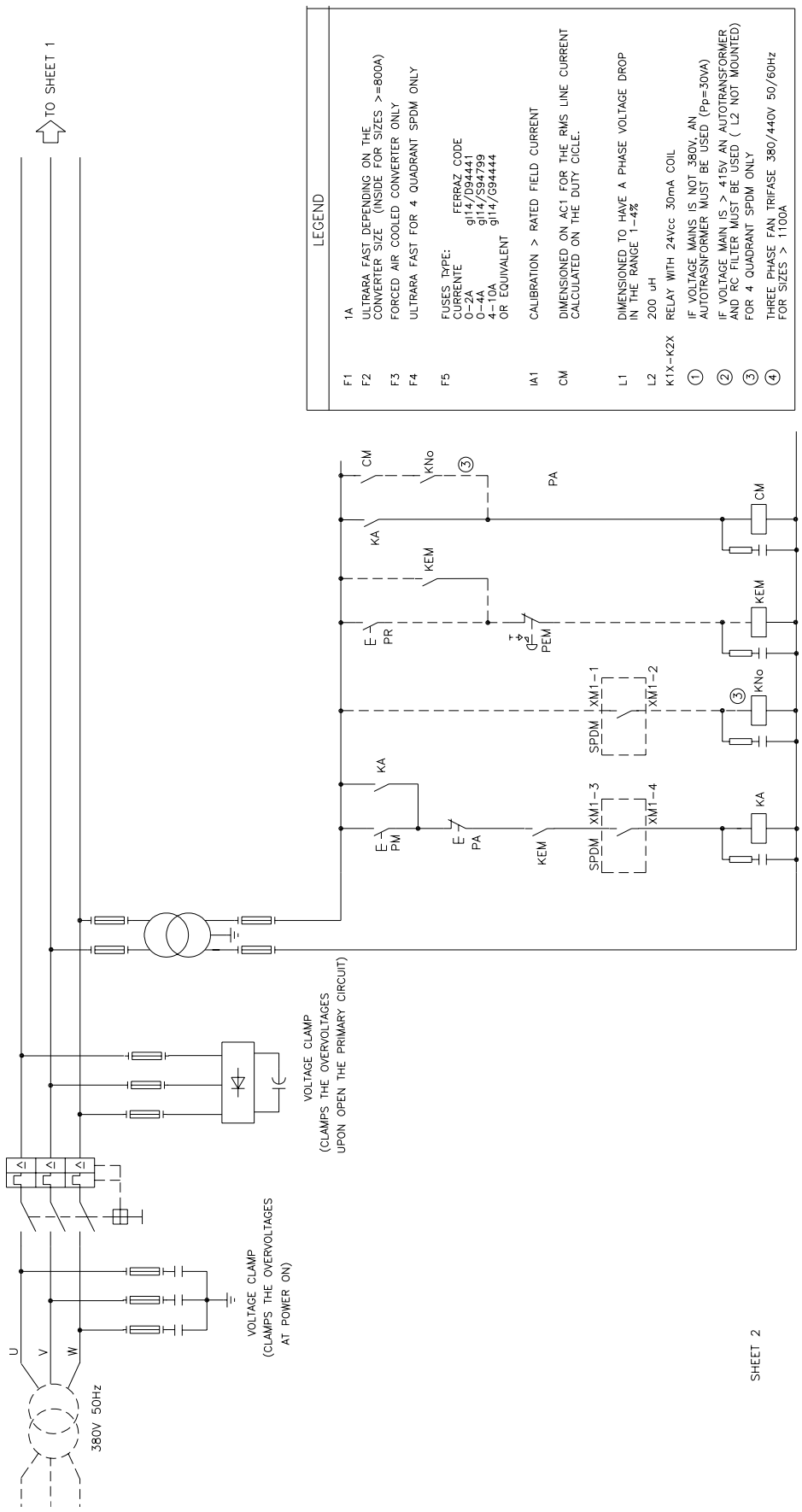
Connection of an Encoder with power supply = 24V and pulses value = 5V.



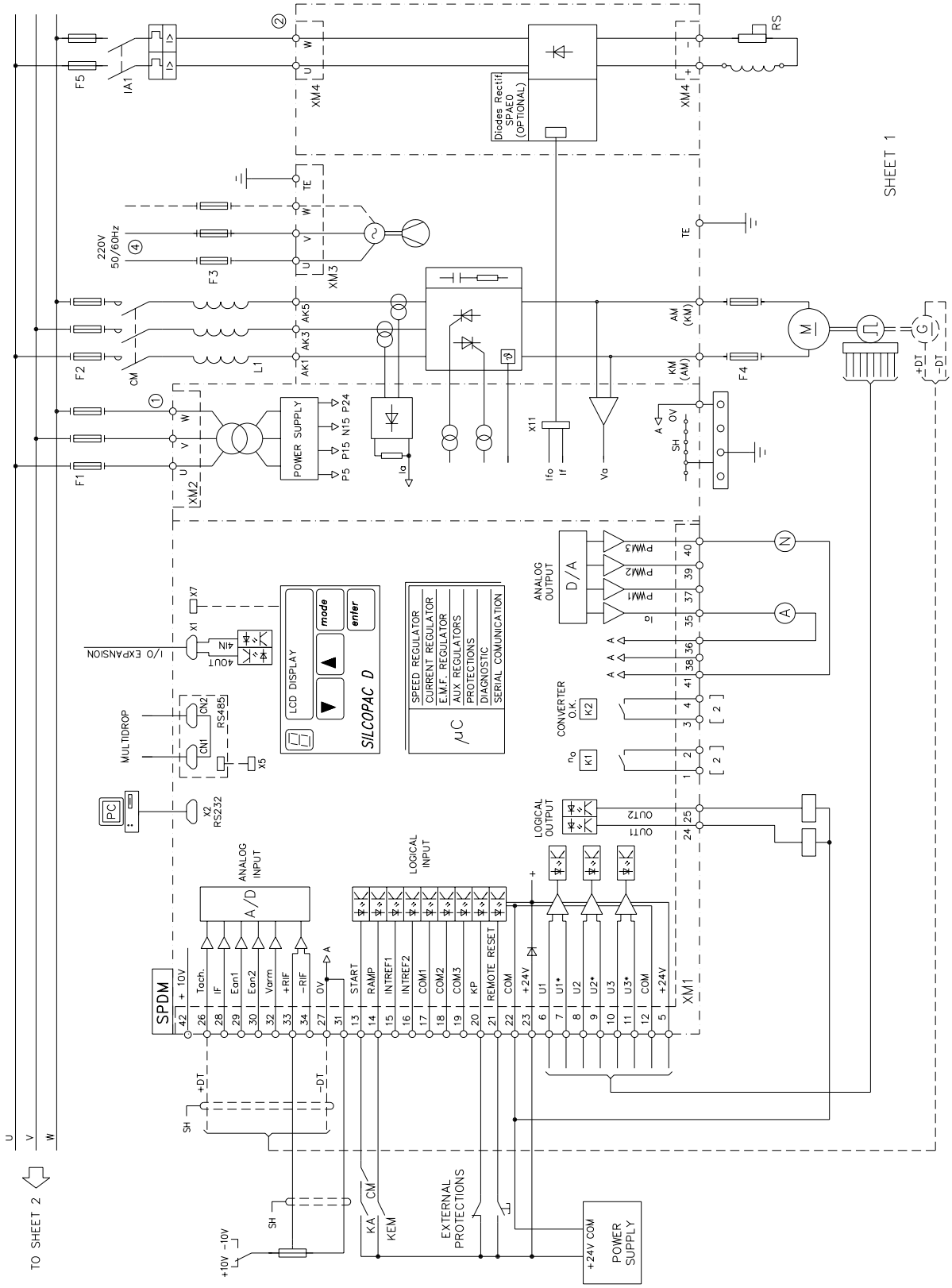
A7.6 Suggested diagrams

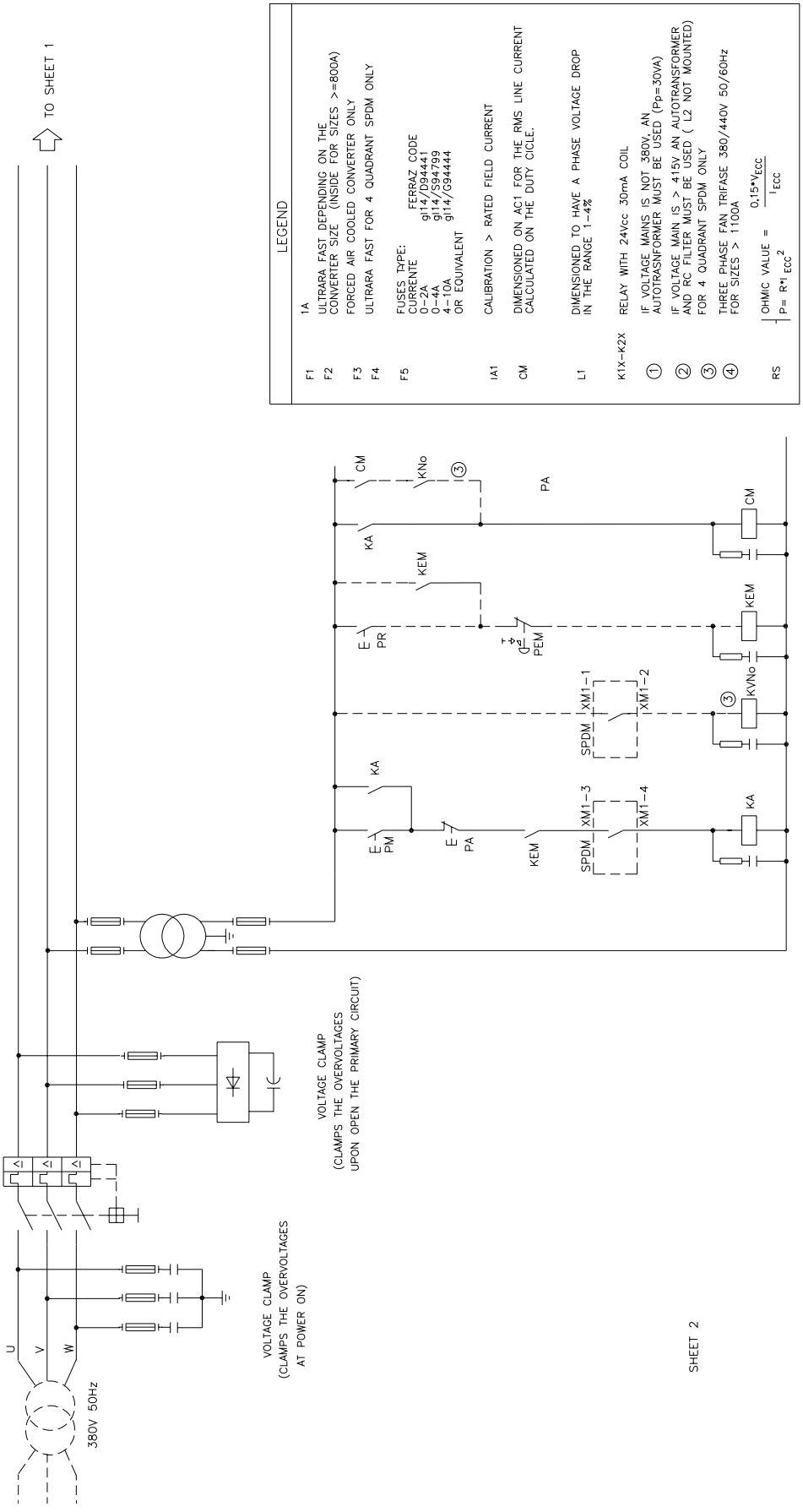
Example of SPDM - exciter connection




LEGEND
F1 1A
F2 ULTRARA FAST DEPENDING ON THE CONVERTER SIZE (INSIDE FOR SIZES >=800A)
F3 FORCED AIR COOLED CONVERTER ONLY
F4 ULTRARA FAST FOR 4 QUADRANT SPDM ONLY
F5 FUSES TYPE: FERRAZ CODE
CURRENTE
0-2A gI14/D94441
0-4A gI14/S94799
4-10A gI14/G94444
OR EQUIVALENT
IA1 CALIBRATION > RATED FIELD CURRENT
CM DIMENSIONED ON AC1 FOR THE RMS LINE CURRENT CALCULATED ON THE DUTY CICLE.
L1 DIMENSIONED TO HAVE A PHASE VOLTAGE DROP IN THE RANGE 1-4%
L2 200 uH
K1X-K2X RELAY WITH 24Vcc 30mA COIL
① IF VOLTAGE MAINS IS NOT 380V, AN AUTOTRASNFORMER MUST BE USED (Pp=30VA)
② IF VOLTAGE MAIN IS > 415V AN AUTOTRANSFORMER AND RC FILTER MUST BE USED (L2 NOT MOUNTED) FOR 4 QUADRANT SPDM ONLY
③ THREE PHASE FAN TRIFASE 380/440V 50/60Hz FOR SIZES > 1100A
TO SHEET 1
U
V
W
380V 50Hz
VOLTAGE CLAMP (CLAMPS THE OVERVOLTAGES AT POWER ON)
VOLTAGE CLAMP (CLAMPS THE OVERVOLTAGES UPON OPEN THE PRIMARY CIRCUIT)
CM
KNo
KA
KEM
E PR
PEM
PA
SPDM
XM1-1
XM1-2
XM1-3
XM1-4
E PM
E PA
SHEET 2

Example of SPDM - rectifier bridge connection




LEGEND
F1 1A
F2 ULTRARA FAST DEPENDING ON THE CONVERTER SIZE (INSIDE FOR SIZES >=800A)
F3 FORCED AIR COOLED CONVERTER ONLY
F4 ULTRARA FAST FOR 4 QUADRANT SPDM ONLY
F5 FUSES TYPE: FERRAZ CODE
CURRENTE
0-2A gl14/D94441
0-4A gl14/S94799
4-10A gl14/G94444
OR EQUIVALENT
IA1 CALIBRATION > RATED FIELD CURRENT
CM DIMENSIONED ON AC1 FOR THE RMS LINE CURRENT CALCULATED ON THE DUTY CICLE.
L1 DIMENSIONED TO HAVE A PHASE VOLTAGE DROP IN THE RANGE 1-4%
K1X-K2X RELAY WITH 24Vcc 30mA COIL
① IF VOLTAGE MAINS IS NOT 380V, AN AUTOTRASNFORMER MUST BE USED (Pp=30VA)
② IF VOLTAGE MAIN IS > 415V AN AUTOTRANSFORMER AND RC FILTER MUST BE USED (L2 NOT MOUNTED) FOR 4 QUADRANT SPDM ONLY
③ THREE PHASE FAN TRIFASE 380/440V 50/60Hz FOR SIZES > 1100A
④ RS OHMIC VALUE = 0,15*VECC / IECC
P= R*I ECC 2
TO SHEET 1
U V W
380V 50Hz
VOLTAGE CLAMP (CLAMPS THE OVERVOLTAGES AT POWER ON)
VOLTAGE CLAMP (CLAMPS THE OVERVOLTAGES UPON OPEN THE PRIMARY CIRCUIT)
CM KNo KA KEM E PR PEM PA
E PM E PA KEM SPDM XM1-1 XM1-2 XM1-3 XM1-4
KVNo
SHEET 2

A7.7 Field circuit

Regulation type	Power	Inside	Outside	Voltage Input	Voltage Output	Requested external components
				V_{IN}	VOUT	
Constant Torque	Single phase rectifier	SPAE0 (10A)		≤ 415V	0,98 V_{IN}	1) tuning field resistor ♦ $\mathbf{R} \cong \frac{\mathbf{V_{OUT} - V_F}}{\mathbf{I_F}}$ [Ω] $\mathbf{P = RI_F^2}$ (W) 2) fuses 3) transformator (auto) if: $V_{IN} \geq 415$ $V_{OUT}/V_{IN} < 0,98$
Constant Torque/Power	Single phase half controlled bridge Voltage forcing during acceleration not possible	SPAE1 (10A)	SPAM (16-45A)	≤ 415V	0,82 V_{IN}	1) line reactor 2) fuses and fuse holders 3) thermal relay 4) (auto) transformer and rc filter if: $v_{IN} > 415v$ $v_{OUT}/v_F > 2$ (c=k); > 1,8 (p=k)
	Three phase fully controlled bridge		SPATE---U SPDME---U	380÷500V	1,15 V_{IN}	See SPAT See SPDM
			SPDME---R	380÷500V	1,05 V_{IN}	See SPDM 1) Discharge resistor

♦ VF = Actual field voltage
IF = Rated field current

GENERAL DATA

Standards		Mains connection		
IEC 146.2 EN61800-3 (EMC) EN 50178 (Low voltage) CE		Three-phase voltage:	G=380-500V ±10%	W=750V ±10%
			H=600V ±10%	M=850V ±10%
			K=690V ±10%	N=950V ±10%
Enviromental conditions		Three-phase control board voltage	380-400V -15%, +10% (30VA)	
Operating temperature:	0-40°C (decrease rated current by 2,5% °C to a maximum of 55°C)	Frequency:	45-65Hz	
Storage temperature::	-20+70°C	Motor connection		
Relative humidity:	95% (no condensation allowed)	Speed accuracy:	0,01% (with encoder transducer) 0,1% (with tacho transducer) 2% (with armature voltage transducer)	
Altitude above above level	1000m. (decrease rated current by 1% for every 100m, up to 3000m)			
	IP20 (protection against accidental contacts)	Speed resolution:	0,005% (with encoder transducer)	
		Dead zone on bridge reversing	3,3ms max	
Forced cooling:	by built in fan	Current regulator bandwidth:	400 rad/s max	
Standard functions		Speed regulator bandwidth:	60 rad/s max	
Motorized potentiometer		Overload:	Duty cycle and base current function	
Acceleration / deceleration time: 0,1-3000s				
Two/for Pre-Set speed		Control connections		
Second set parameters (changeable)		One differential analog inputs: 0-10V, 0-20mA		10bit + sign
Speed feedback swithing		Two auxliliary programmable analog inputs (Ean1-2): 0-		9bit + sign
E.M.F., current, speed selftuning		Two auxliliary programmable analog inputs (Tach-If): 0-		9bit + sign
Armature current rate limit (adjustable)		One auxilary analog input (Varm): 0-10V		9bit + sign
PID controller		One output: +10V, 5mA (short cicuit protection)		
Angular speed as function of the diameter		One analog output: 0+-10V (armature current)		
Torque proof (lifting applications)		Three programmable analog outputs (PWM1-2-3): 0-10V (torque/ current, motor voltage, speed, power, etc.)		8bit + sign
Load weighting (lifting applications)				
Restart after power supply failure		Relay outputs (NO): DRIVE OK		
Helper		Relay outputs (NO): Minimum speed		
Pope (paper applications)		Two programmable digital outputs (24Vdc) (active alarm, minimum speed, attained frequency, speed/current threshold etc.)		
Step				
Mechanical friction compensation		Nine optoisolated digital (24Vdc) inputs (3 programmable)		
Thyristor trace and drive trace		Three channel encoder optoisolated inputs		
Programmable security code (password)		Half duplex serial outputs RS232/485		
Protections		Options and accessories		
Watchdog		Input reactors.		
Input phase loss		RFI filter		
Over/under voltage		U.R. fuses and fuse holders		
Drive overload		ATRS Synchronism autotransformer		
Drive overtemperature		SPAE1 Built-in exciter (10A, Vin=415V max)		
Overcurrent (IOC)		SPAM Exciter (16-35-50A, Vin=415V max)		
Leg failure		0-10V / (0)4-20mA optoisolated converter (two channels).		
Motor overload		SPDIO Digital I/O expansion board I/O		
Maximum speed		SPPB1 Profibus-DP kit		
Armature overvoltage		SPDI1 Keypad	remotable 2m, with liquid crystal display.	
Speed transducer / loss		SPDI2 Keypad with printer connector	(2 line x16 characters) 10 keys.	
Motor stall prevention		PS24 (2,2A) Logics I/O 24 Vdc power supply. Vin=85/265Vac		
Serial link loss		***Optional software versions***		
External protection		"S" Accurated speed ratio, "M"Spindle, "W" Ward leonard (field regulator)		

A8 OVERLOAD CURVES

The overload curves, according to IEC 1136 - 1 Standard, are evaluated on a periodic cycle as shown by Fig. 1, at 40 °C ambient temperature. In the Iv = 0 particular case, the load cycle appears as shown by Fig. 2.

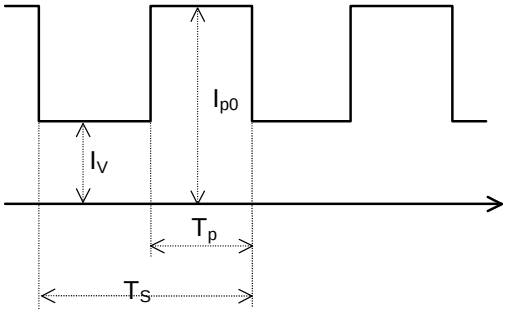


Figure 1

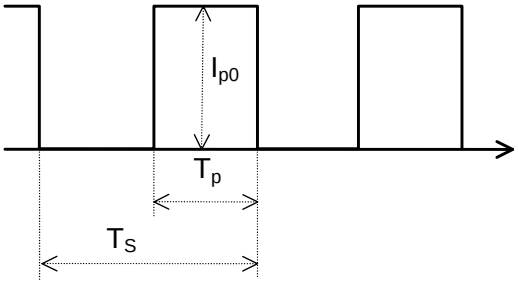


Figure 2

Iv = converter current before the overload.
Ip = current during the overload; at the end of each Tp period, the thyristor temperature reaches the maximum allowed value.
Ipo = current during the overload in the Iv = 0 particular case.
Ts = cycle period.
Tp = overload duration.

A curve family is related to each converter represented by a diagram; Fig. 4 shows, as example, the diagram related to Silcopac SPDM 600 converter (nominal current Inom = 600 A) . The diagram is normally used to evaluate the Ip value starting from the known values of Inom, Iv, Tp and Ts in the following way:

- from the Fig. 4 example: Inom = 600 A
  Iv = 240 A
  Ts = 50 s
  Tp = 10 s

- the Tp / Ts ratio has to be evaluated at point A (Tp / Ts = 10 / 50 = 0.2);
- trace the vertical line from A to the intersection B with the curve related to the time Tp (Tp = 10 s);
- trace the horizontal line from B to the intersection C with the line PQ related to the ratio Iv / Inom = 0.0;
- trace the vertical line from C to the intersection D with the curve related to the ratio Iv / Inom (Iv / Inom = 240 / 600 =0.4);
- trace the horizontal line from D to the intersection E with the vertical axis Ip/Inom, where the value of this ratio can be read (Ip/Inom = 1.32), from which Ip can be evaluated multiplying by Inom (Ip = 1.32 x 600 = 792 A).

Note 1: the AB segment value, read on the vertical axis, gives the Ipo / Inom ratio from which Ipo can be evaluated (AB = 1.47; Ipo = 1.47 x 600 = 882 A).

Note 2: the non-repetitive load cycle shown by Fig. 3 can be considered a particular case of the cycle shown by Fig. 1, where the Ts time becoms infinitely large.

The diagram shown by Fig. 5 is used as just described, entering at point A with Tp / Ts = 0; from A go up to B (Tp = 10 s); from B to point C on line PQ; from C go down to point D (Iv / Inom = 0.4) and from D to point E, where Ip / Inom = 1.43 can be read.

Then:

Ip = 1.43 x Inom = 1.43 x 600 = 858 A

Ip / Iv = 858 / 240 = 3.575 (or Ip / Iv = 1.43 / 0.4 = 3.575)

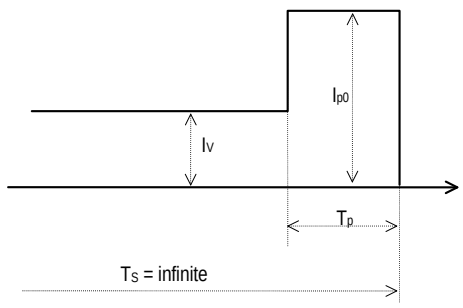


Figure 3

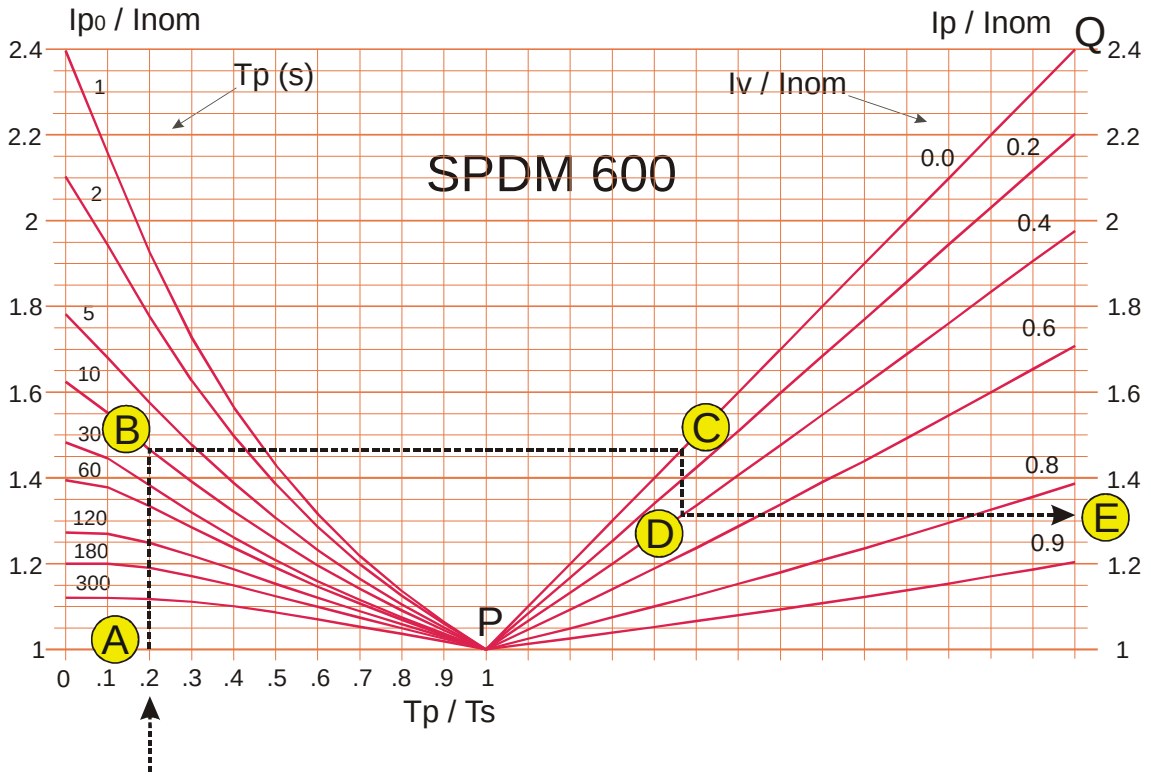


Figure 4

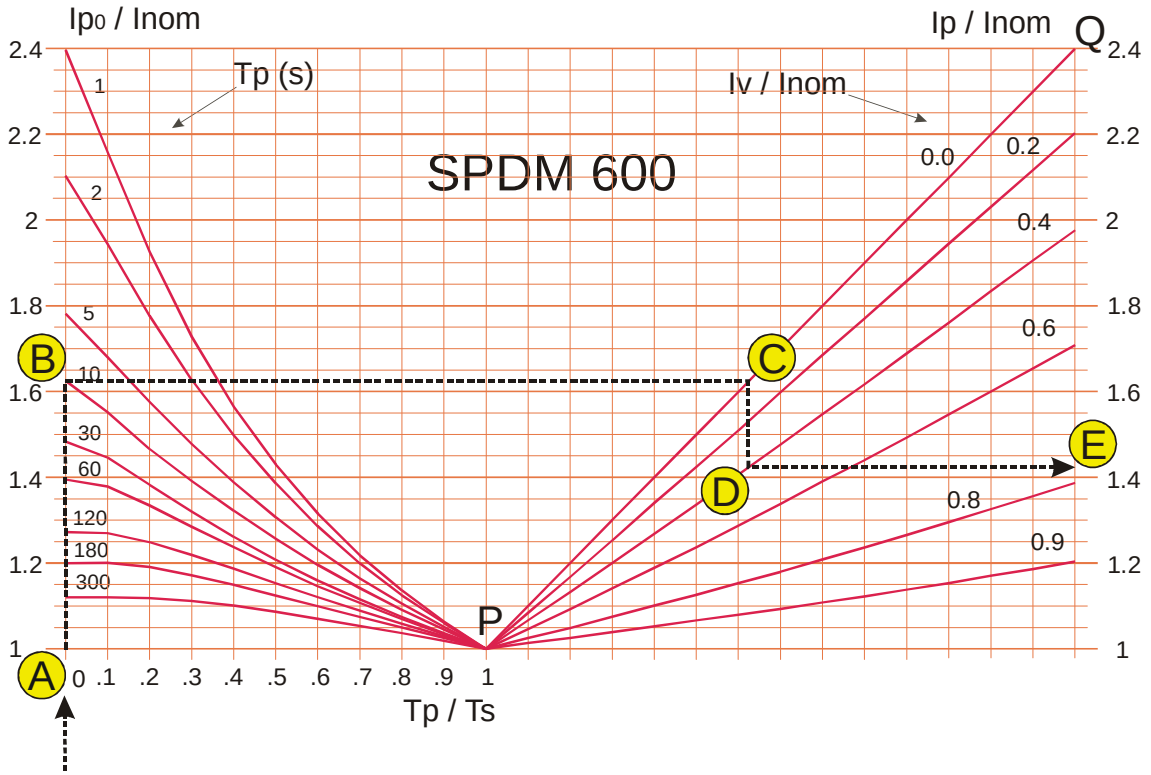
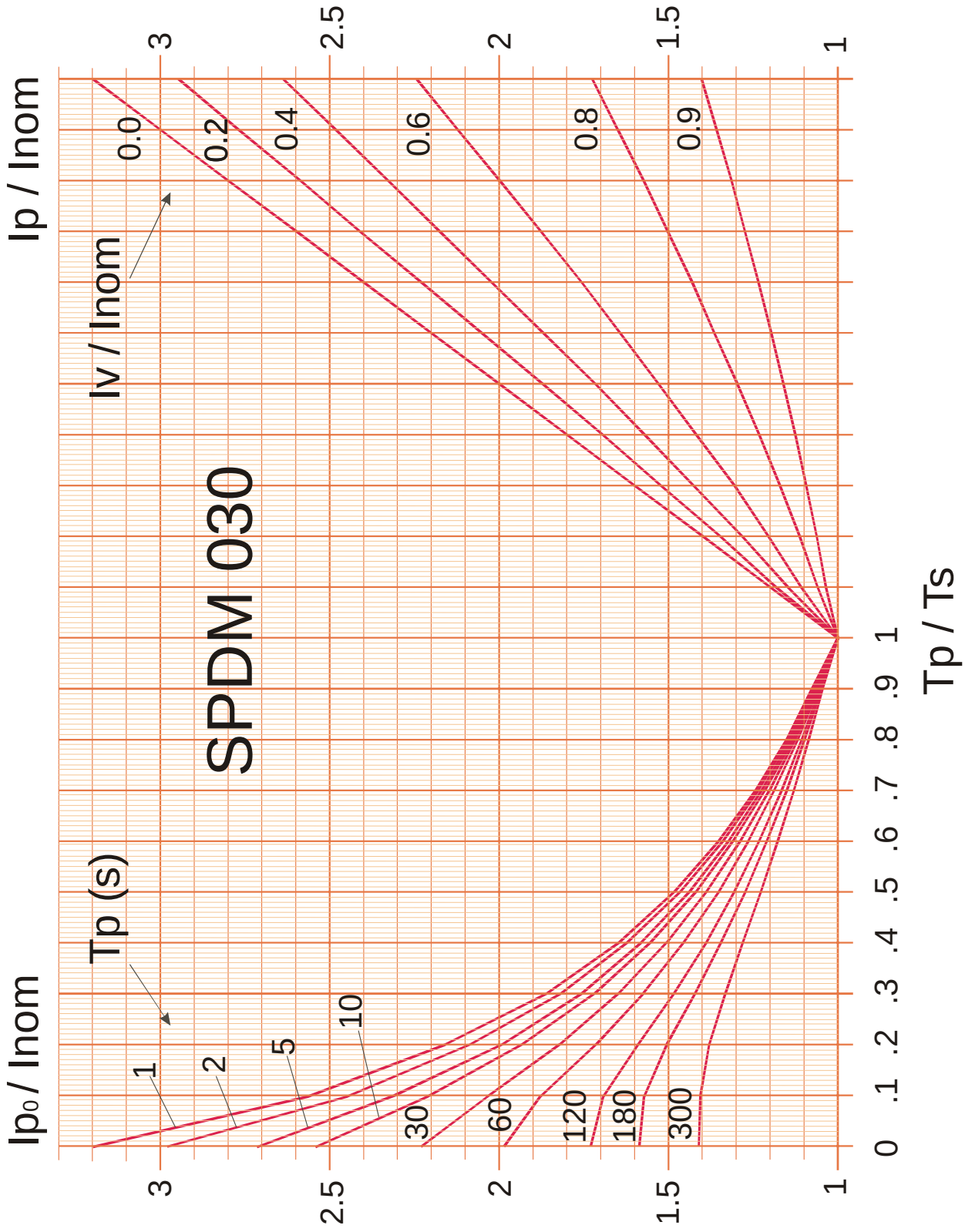
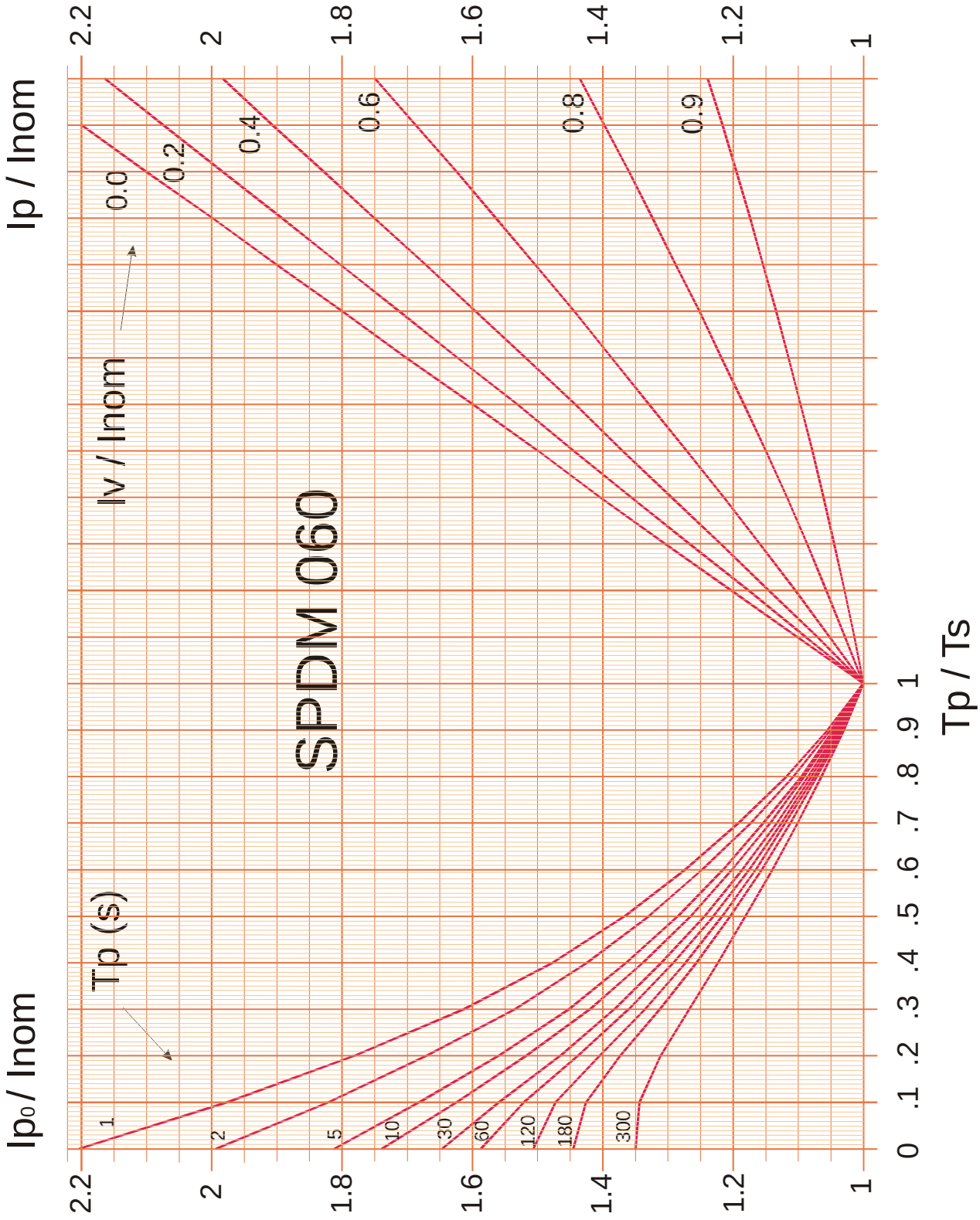
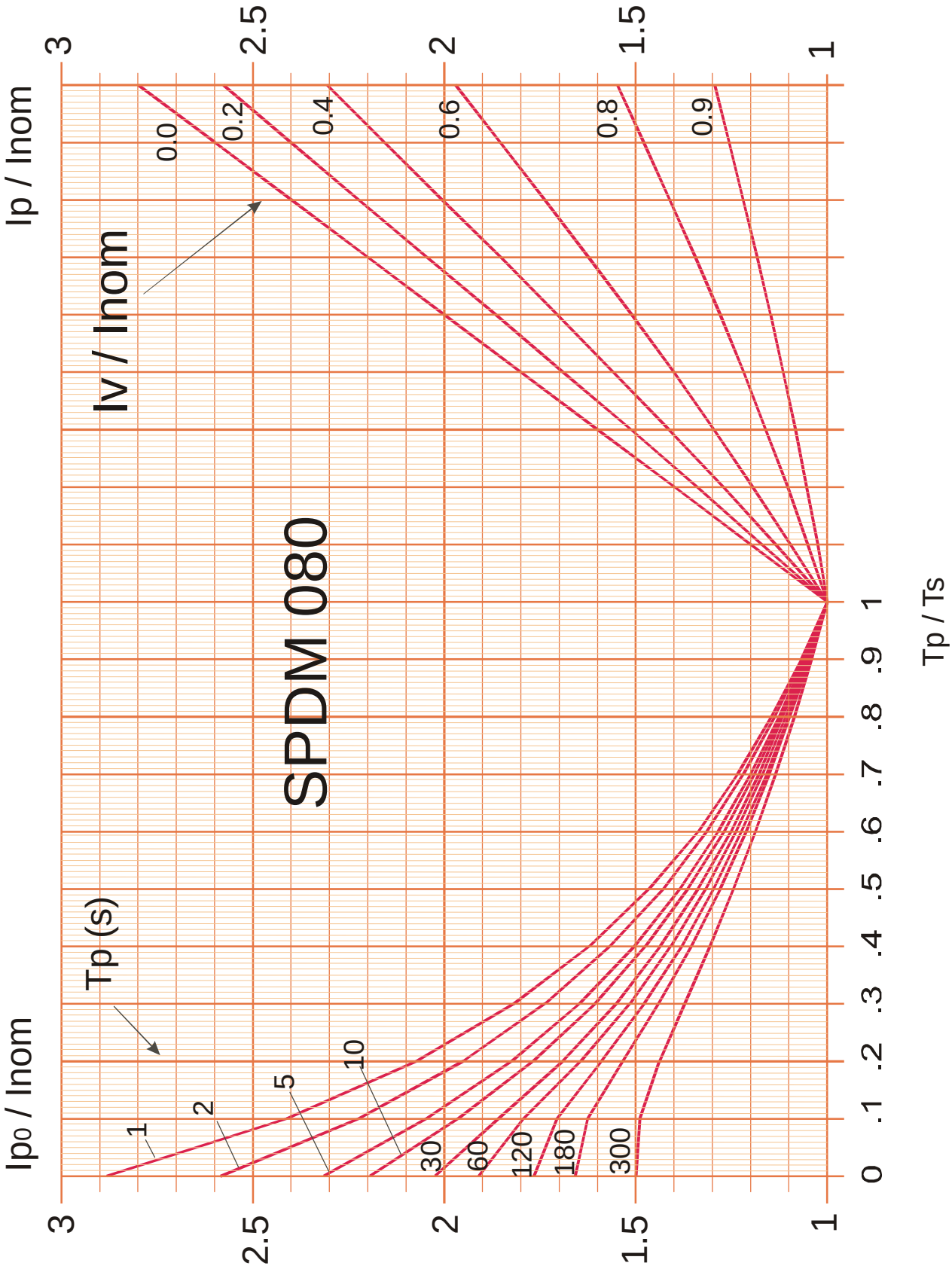
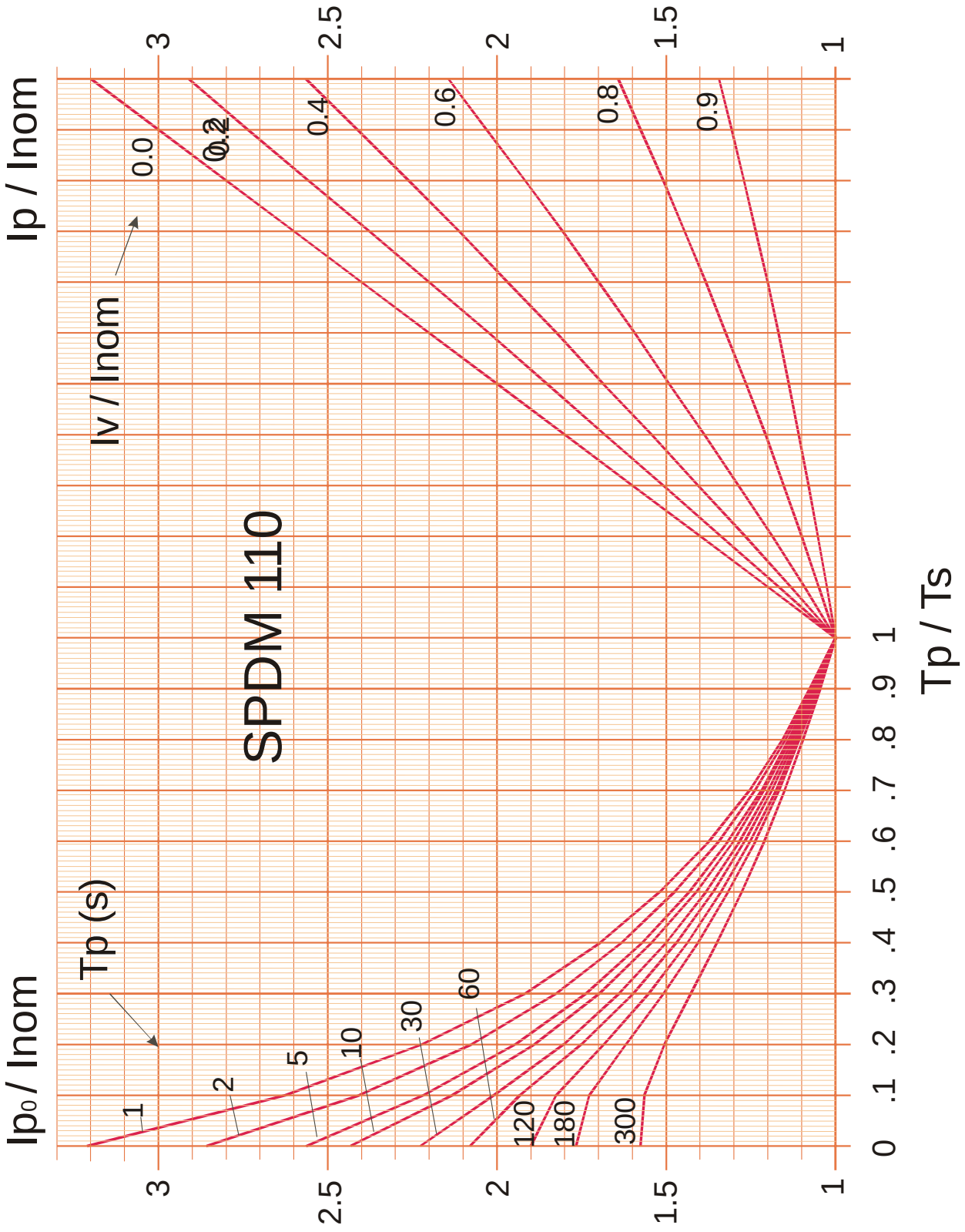


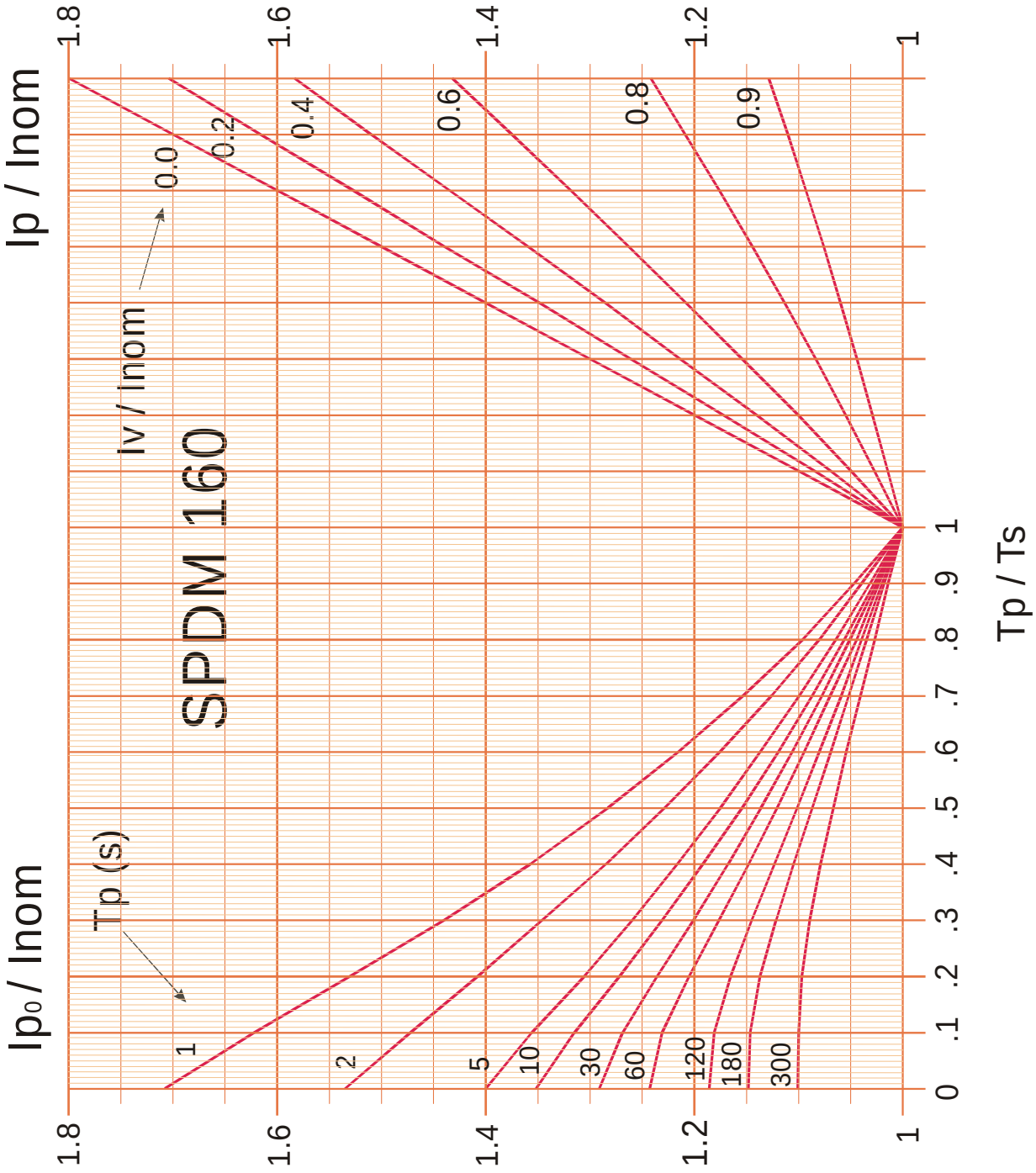
Figure 5

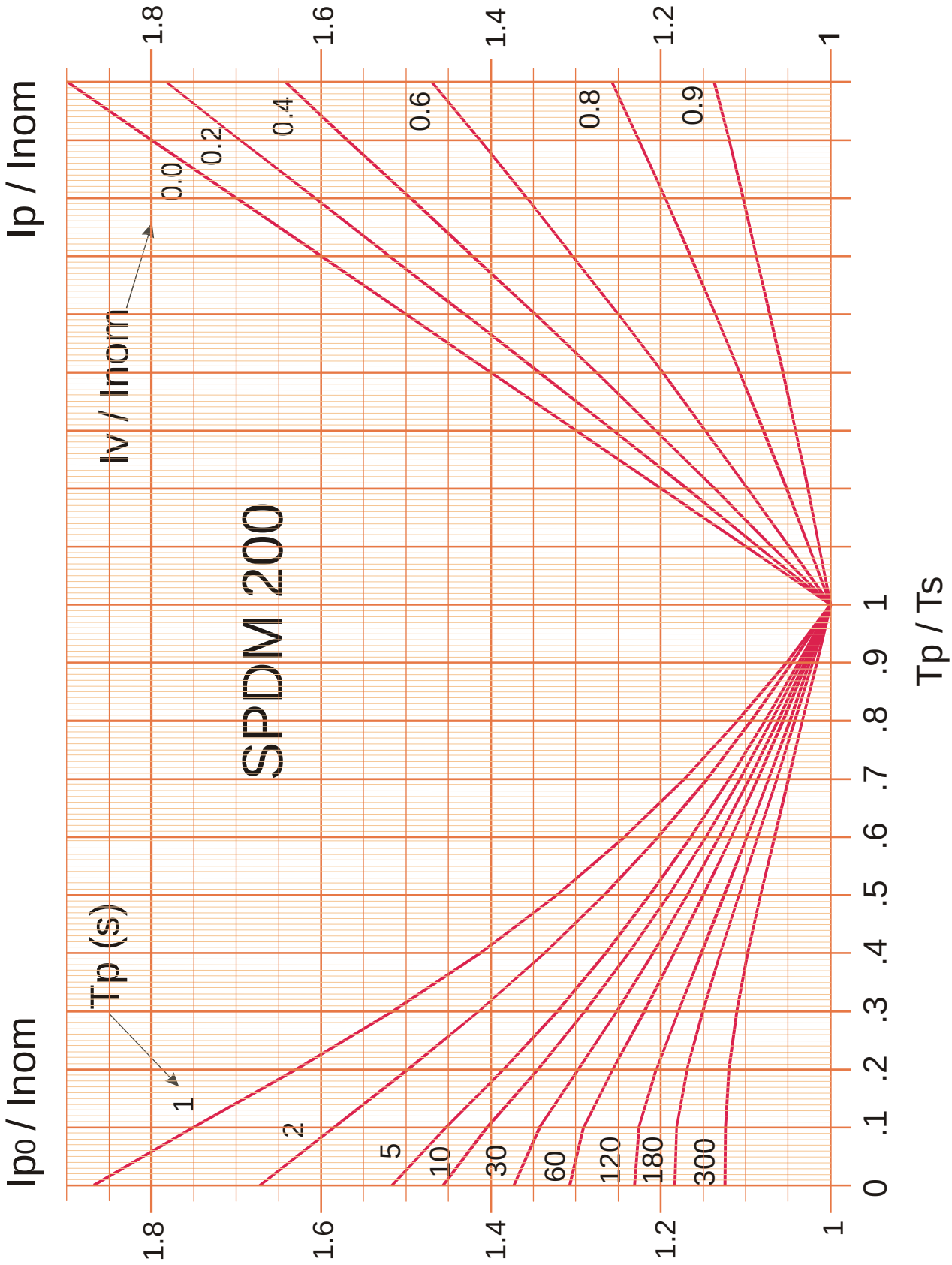

SPDM 030
Ip / Inom
Iv / Inom
0.0
0.2
0.4
0.6
0.8
0.9
Tp (s)
1
2
5
10
30
60
120
180
300
Ip0 / Inom
Tp / Ts
3
2.5
2
1.5
1
0 .1 .2 .3 .4 .5 .6 .7 .8 .9 1

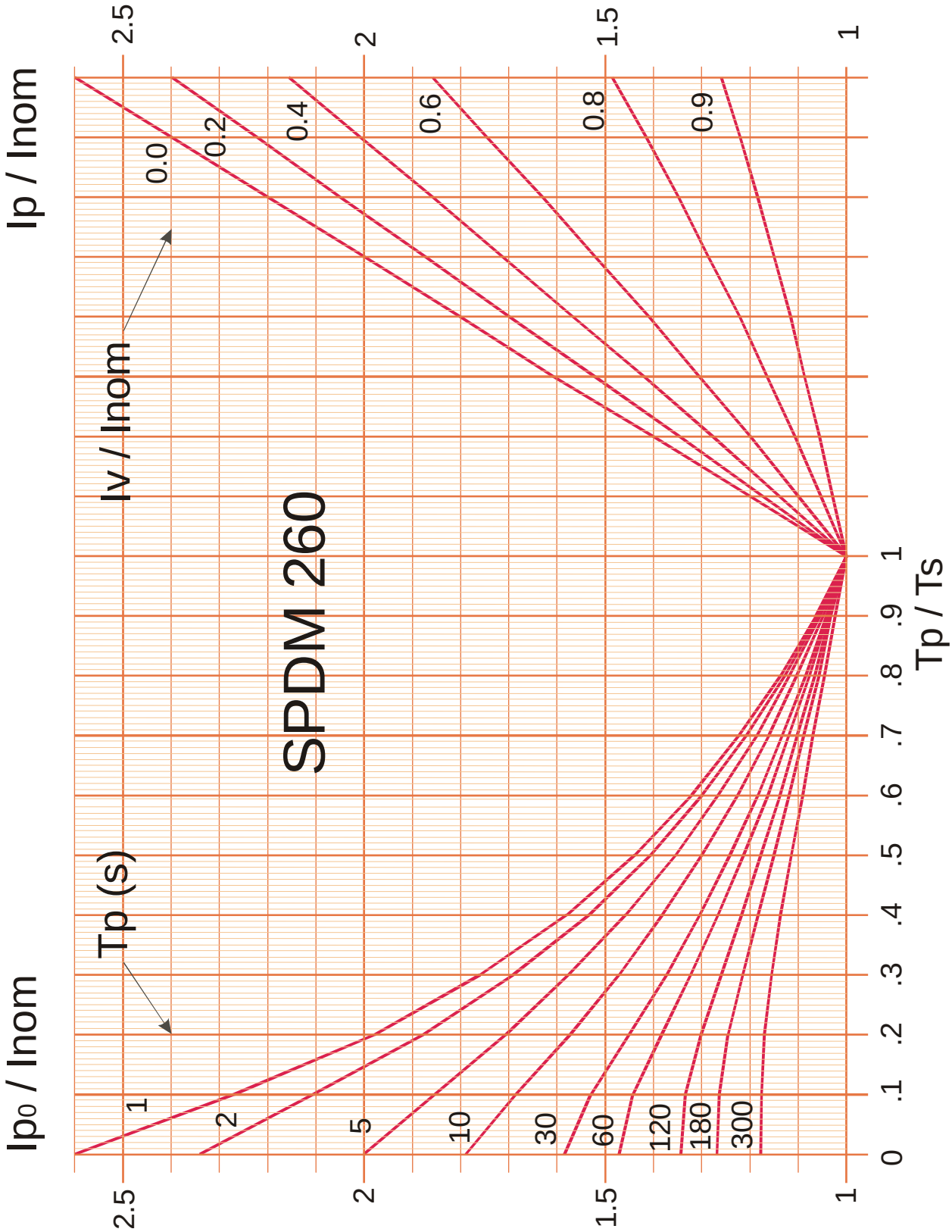

Ip / Inom
Iv / Inom
0.0
0.2
0.4
0.6
0.8
0.9
SPDM 060
Tp (s)
1
2
5
10
30
60
120
180
300
Ip0 / Inom
Tp / Ts
2.2
2
1.8
1.6
1.4
1.2
1
0 .1 .2 .3 .4 .5 .6 .7 .8 .9 1

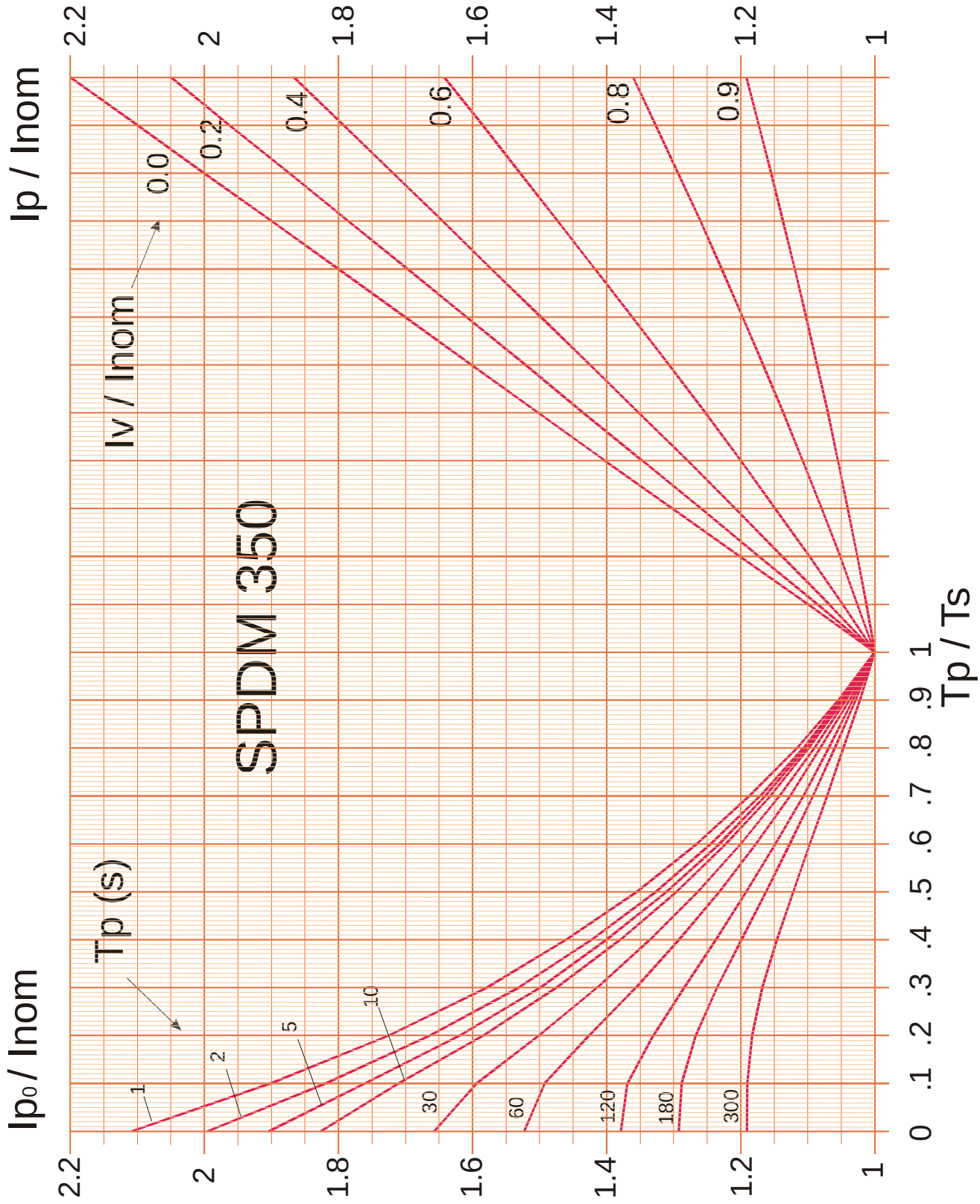

SPDM 080
Ip / Inom
Iv / Inom
Ip0 / Inom
Tp (s)
Tp / Ts
0.0
0.2
0.4
0.6
0.8
0.9
1
2
5
10
30
60
120
180
300
3
2.5
2
1.5
1
0
.1
.2
.3
.4
.5
.6
.7
.8
.9

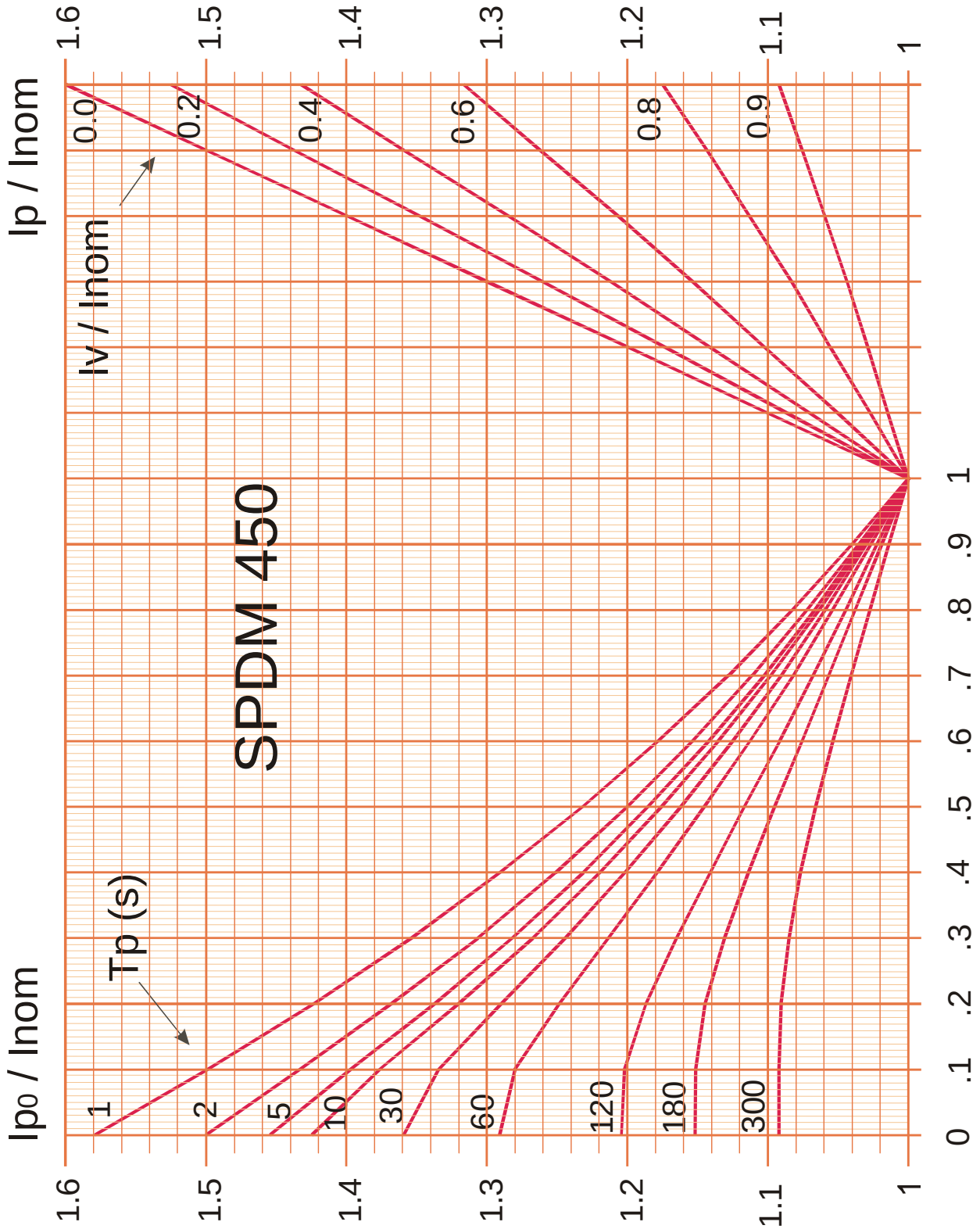

SPDM 110
Ip / Inom
Iv / Inom
Ip0 / Inom
Tp (s)
Tp / Ts
0.0
0.2
0.4
0.6
0.8
0.9
1
2
5
10
30
60
120
180
300
3
2.5
2
1.5
1
0 .1 .2 .3 .4 .5 .6 .7 .8 .9 1

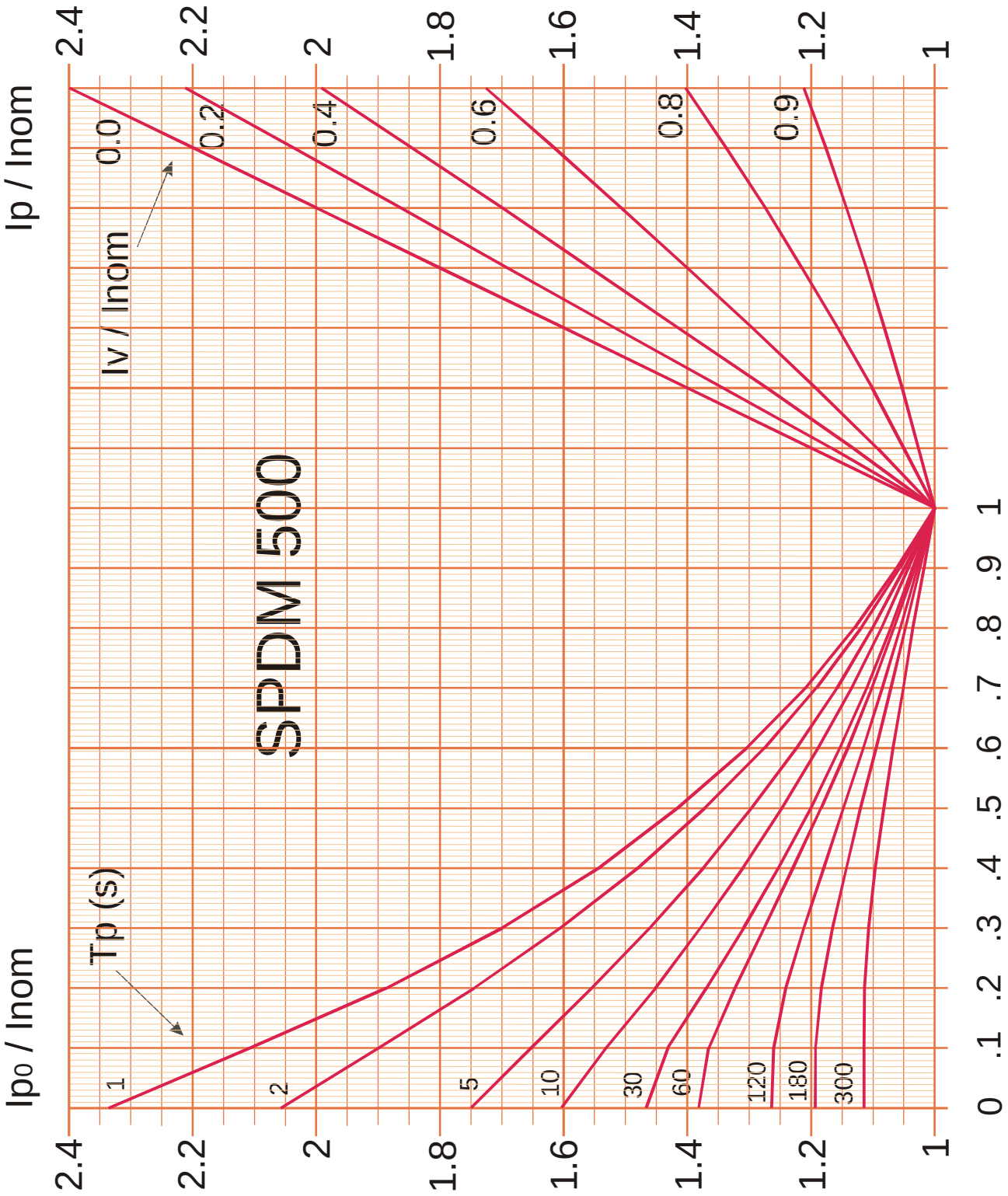

Ip / Inom
Ip0 / Inom
Tp / Ts
Iv / Inom
0.0
0.2
0.4
0.6
0.8
0.9
Tp (s)
1
2
5
10
30
60
120
180
300
SPDM 160
1.8
1.6
1.4
1.2
1
0 .1 .2 .3 .4 .5 .6 .7 .8 .9 1

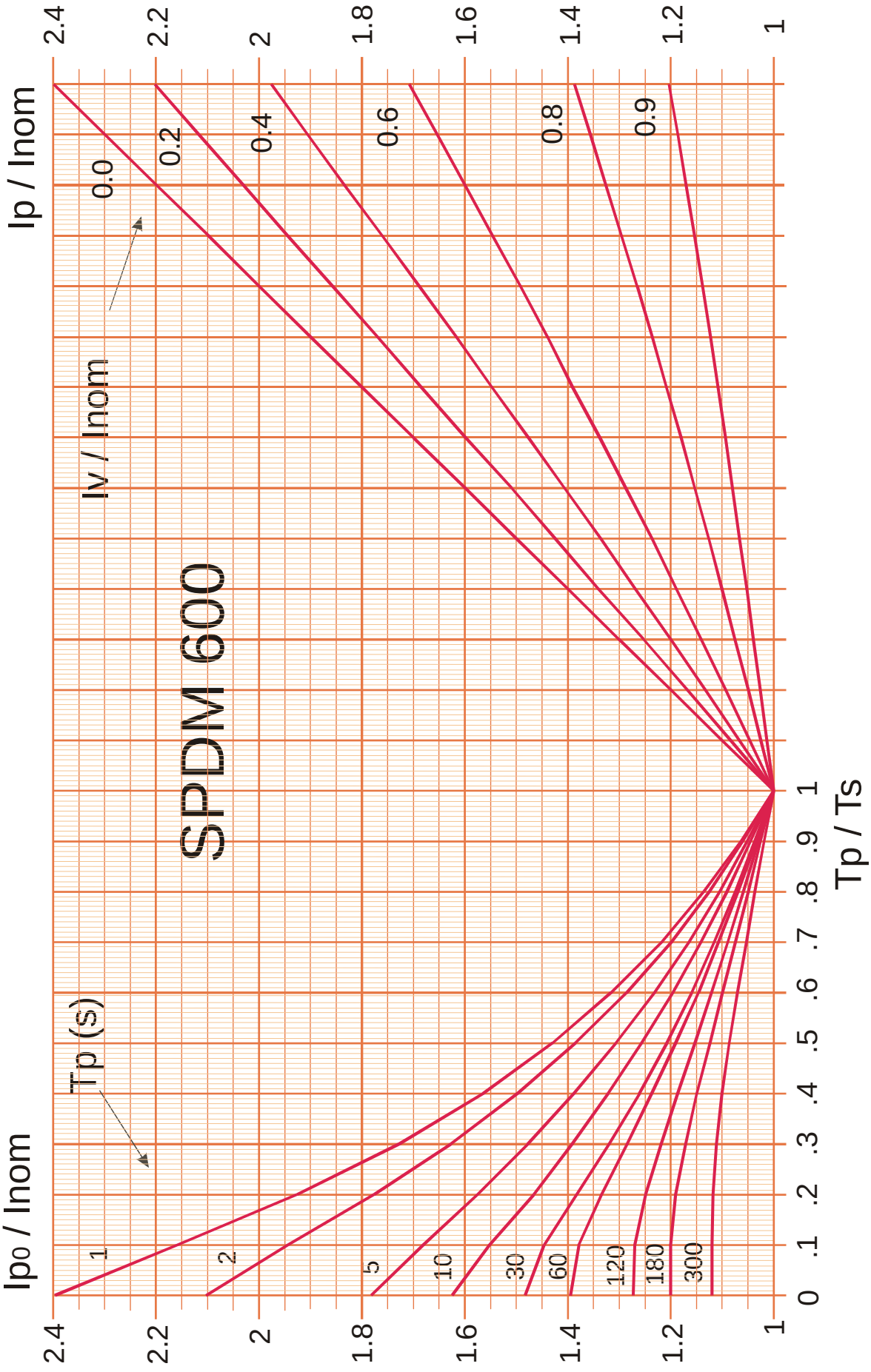

Ip / Inom
Ipo / Inom
Iv / Inom
Tp (s)
SPDM 200
Tp / Ts
0.0
0.2
0.4
0.6
0.8
0.9
1
2
5
10
30
60
120
180
300
1.8
1.6
1.4
1.2
1
0 .1 .2 .3 .4 .5 .6 .7 .8 .9 1

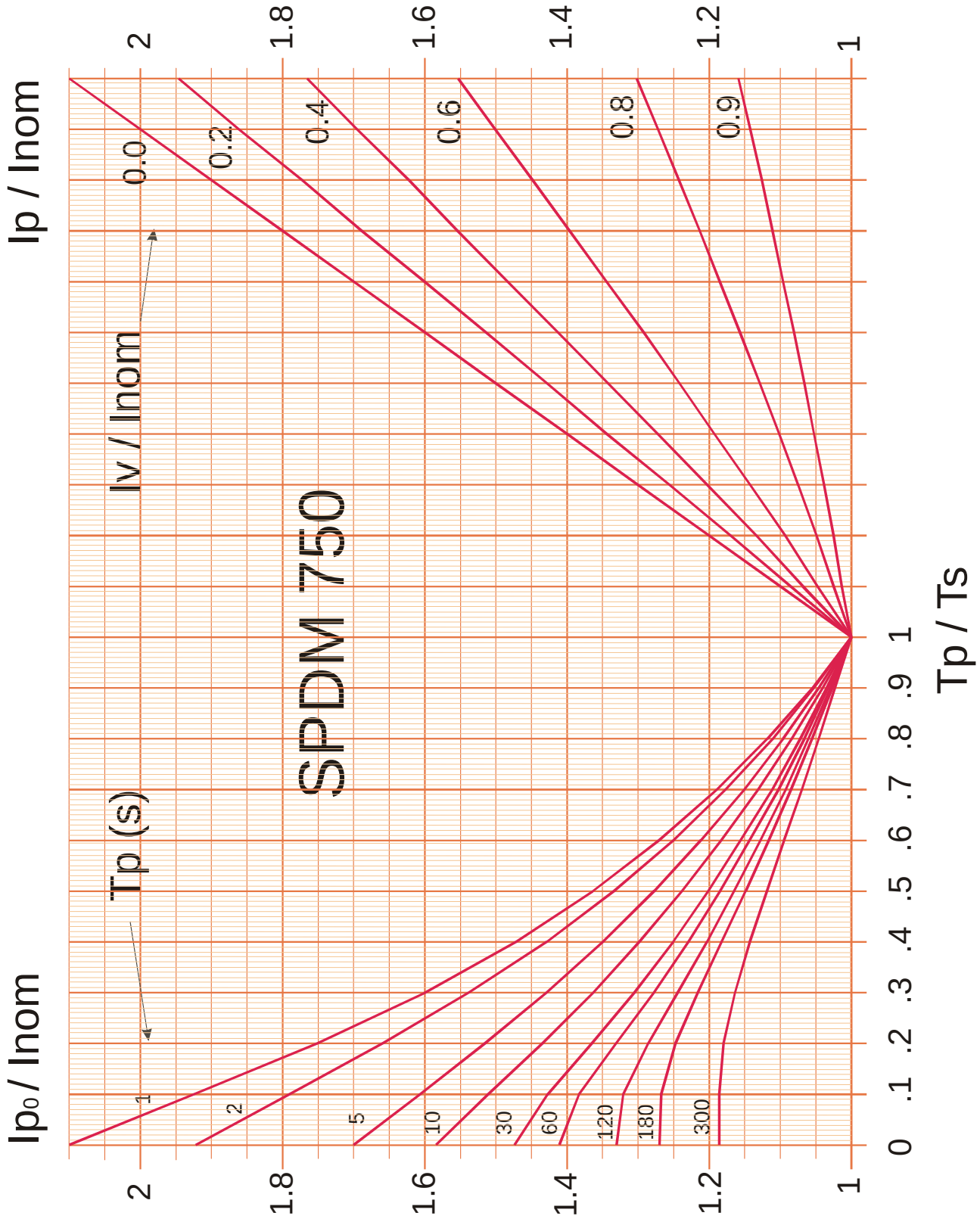

SPDM 260
Ip / Inom
Iv / Inom
Ipo / Inom
Tp (s)
Tp / Ts
0.0
0.2
0.4
0.6
0.8
0.9
1
2
5
10
30
60
120
180
300
2.5
2
1.5
1
0
.1
.2
.3
.4
.5
.6
.7
.8
.9

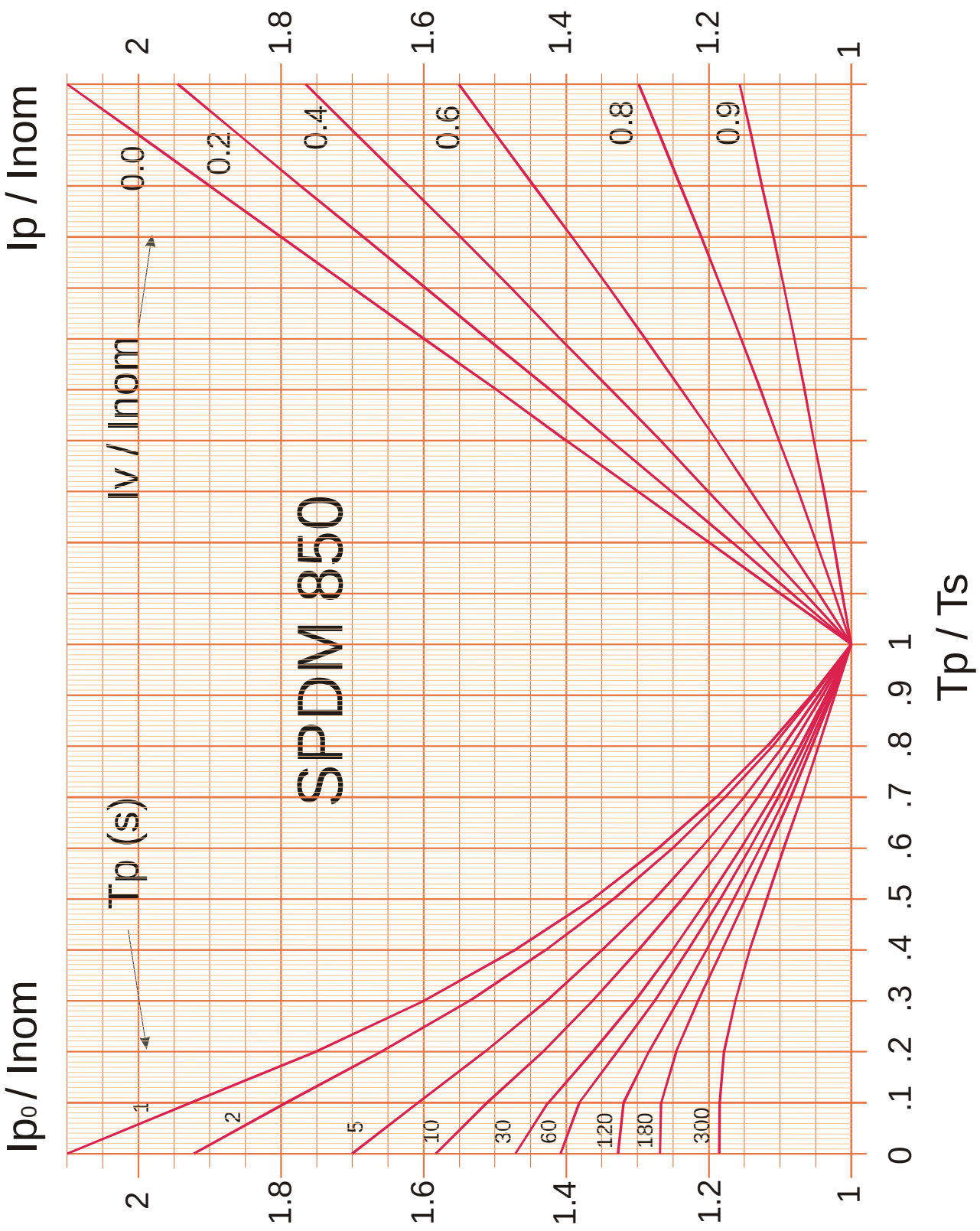

Ip / Inom
Iv / Inom
0.0
0.2
0.4
0.6
0.8
0.9
SPDM 350
Tp (s)
1
2
5
10
30
60
120
180
300
Ip0 / Inom
Tp / Ts
2.2
2
1.8
1.6
1.4
1.2
1
0 .1 .2 .3 .4 .5 .6 .7 .8 .9 1

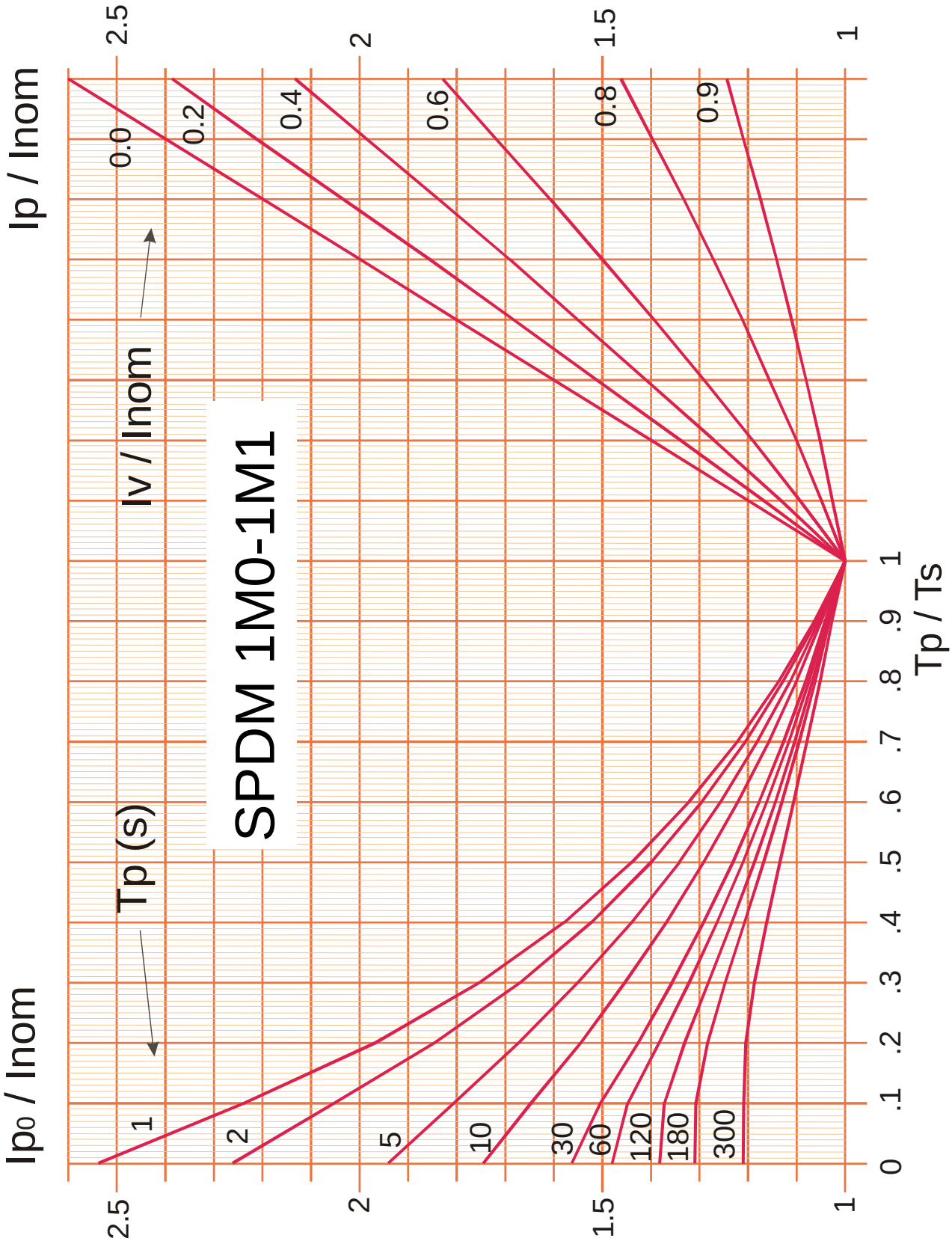

SPDM 450
Ip / Inom
Iv / Inom
Ipo / Inom
Tp (s)
0.0
0.2
0.4
0.6
0.8
0.9
1
2
5
10
30
60
120
180
300
1.6
1.5
1.4
1.3
1.2
1.1
1
0
.1
.2
.3
.4
.5
.6
.7
.8
.9
1

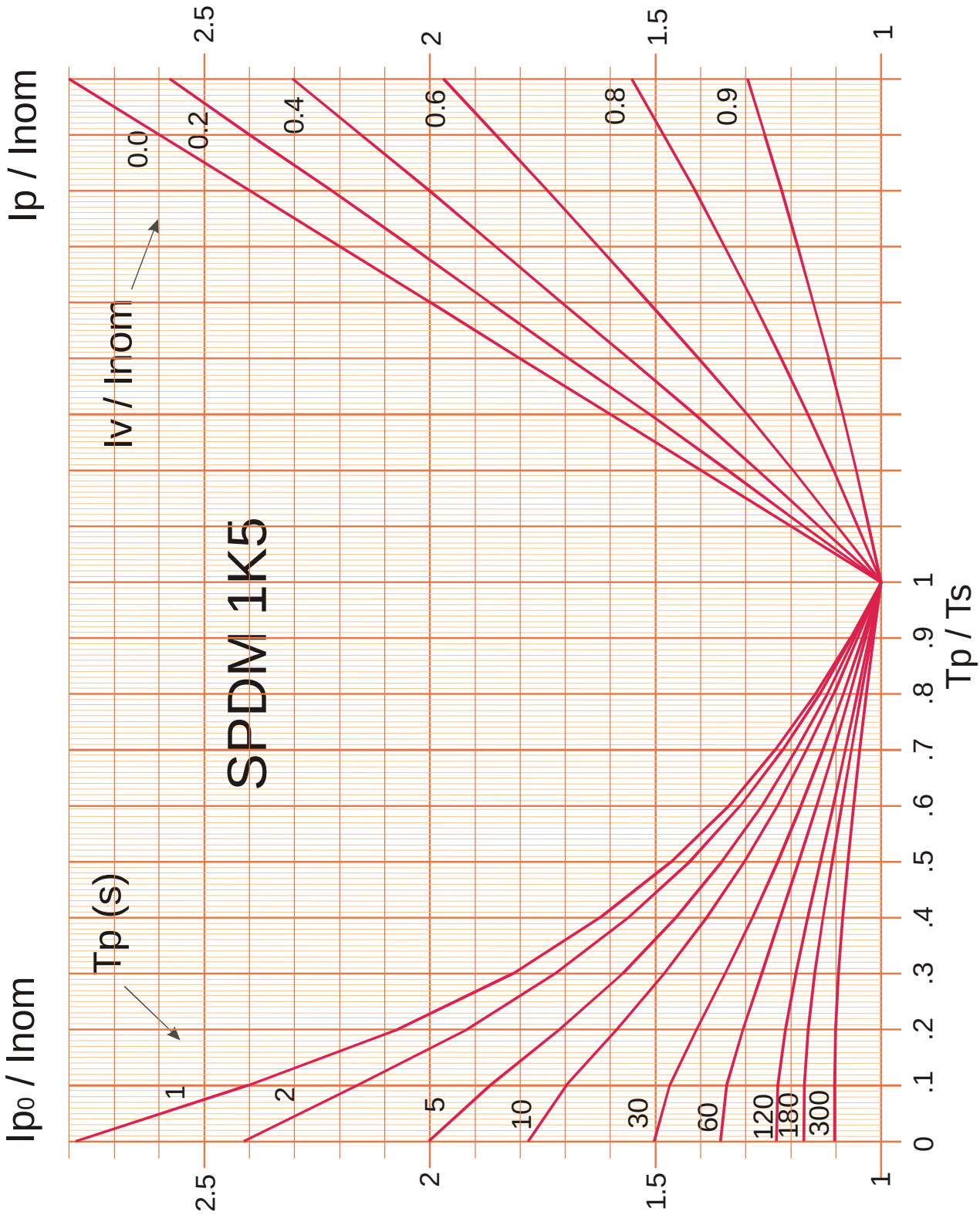

SPDM 500
Ip / Inom
Iv / Inom
Ip0 / Inom
Tp (s)
0.0
0.2
0.4
0.6
0.8
0.9
1
2
5
10
30
60
120
180
300
2.4
2.2
2
1.8
1.6
1.4
1.2
1
0 .1 .2 .3 .4 .5 .6 .7 .8 .9 1

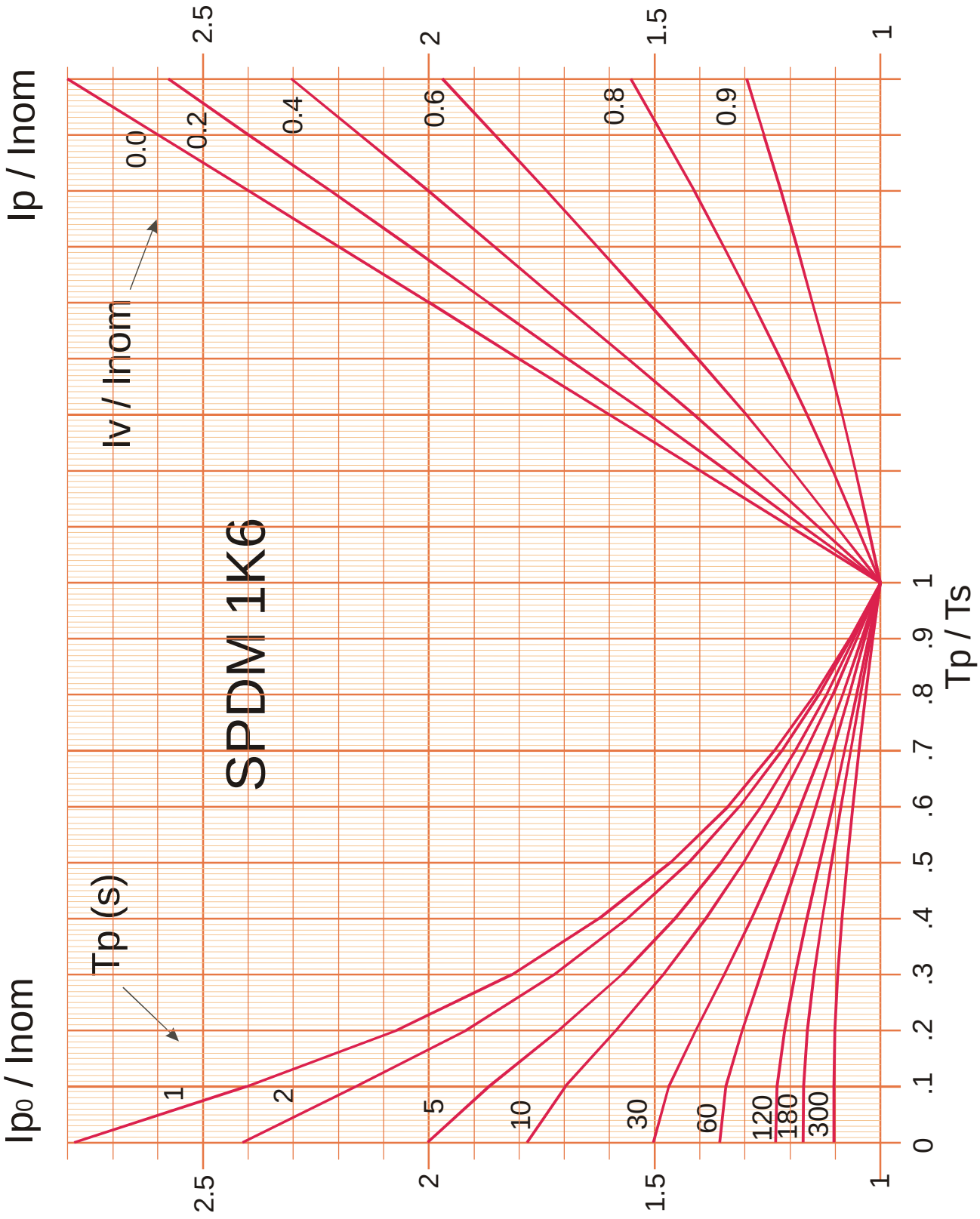

SPDM 600
Ip / Inom
Iv / Inom
0.0
0.2
0.4
0.6
0.8
0.9
Tp (s)
1
2
5
10
30
60
120
180
300
Ipo / Inom
Tp / Ts
2.4
2.2
2
1.8
1.6
1.4
1.2
1
0 .1 .2 .3 .4 .5 .6 .7 .8 .9 1

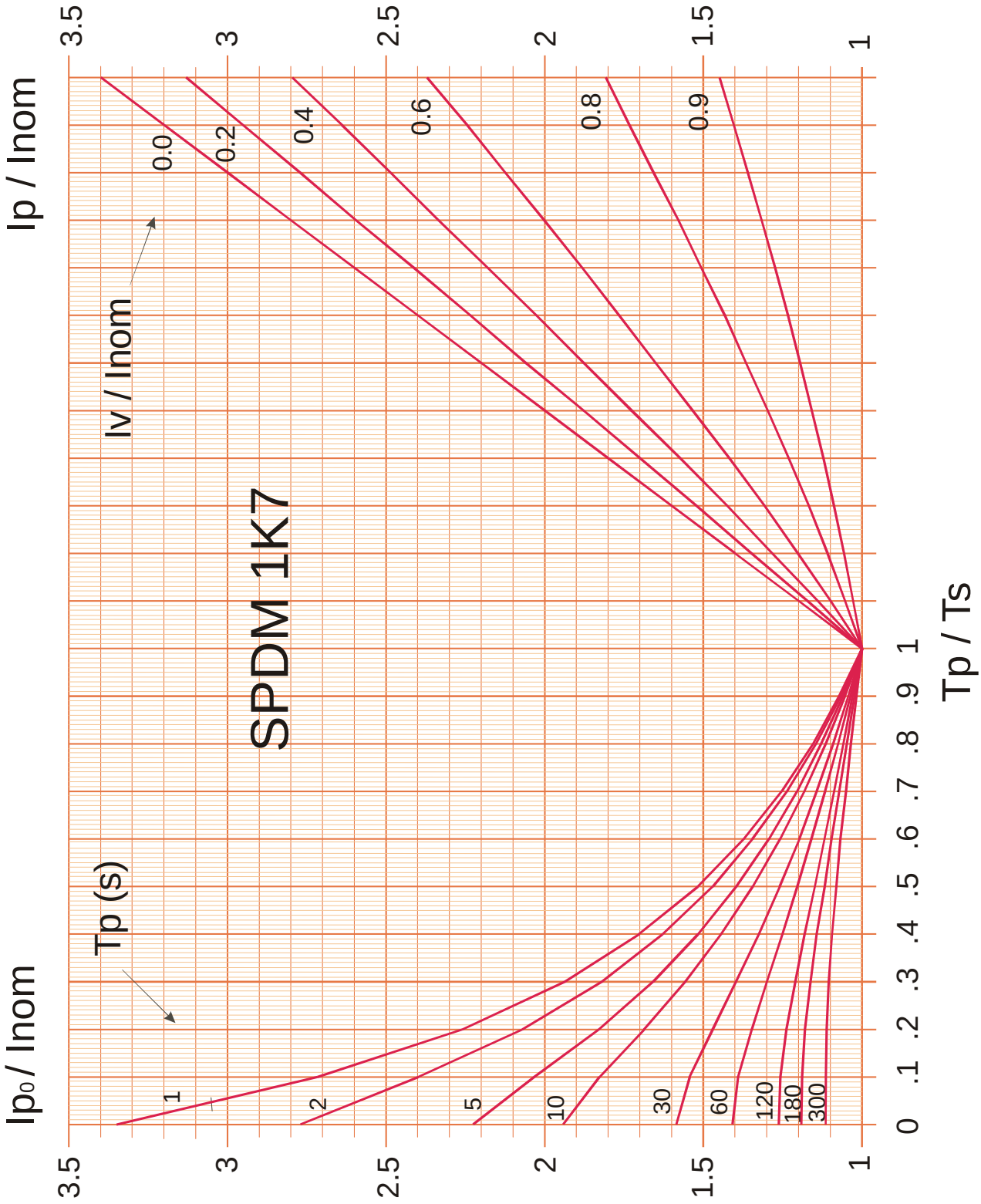

Ip / Inom
Iv / Inom
0.0
0.2
0.4
0.6
0.8
0.9
Tp (s)
1
2
5
10
30
60
120
180
300
SPDM 750
Ip0 / Inom
Tp / Ts
2
1.8
1.6
1.4
1.2
1
0 .1 .2 .3 .4 .5 .6 .7 .8 .9 1

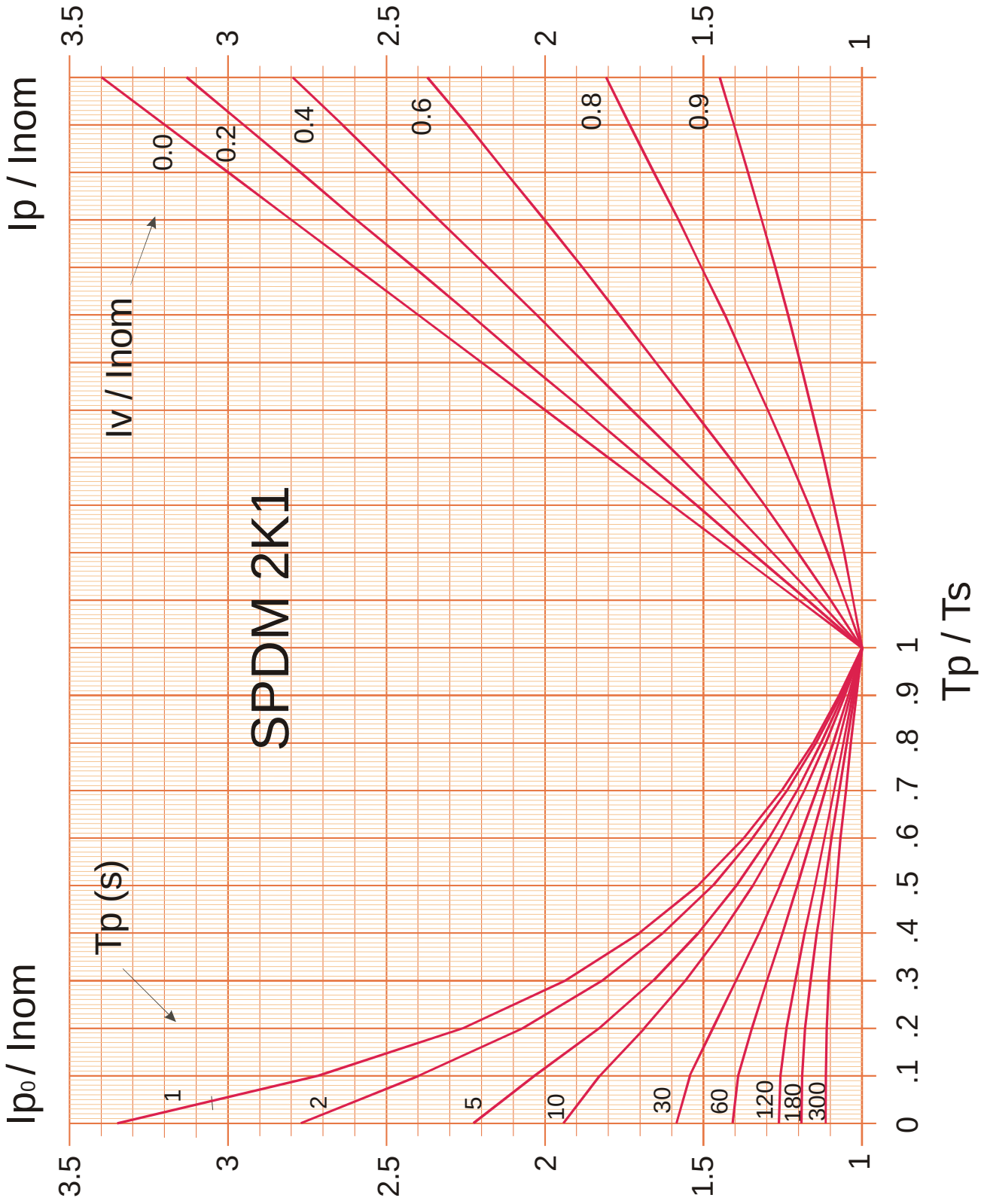

Ip / Inom
Iv / Inom
0.0
0.2
0.4
0.6
0.8
0.9
Tp (s)
1
2
5
10
30
60
120
180
300
SPDM 850
Ip0 / Inom
Tp / Ts
2
1.8
1.6
1.4
1.2
1
0 .1 .2 .3 .4 .5 .6 .7 .8 .9 1

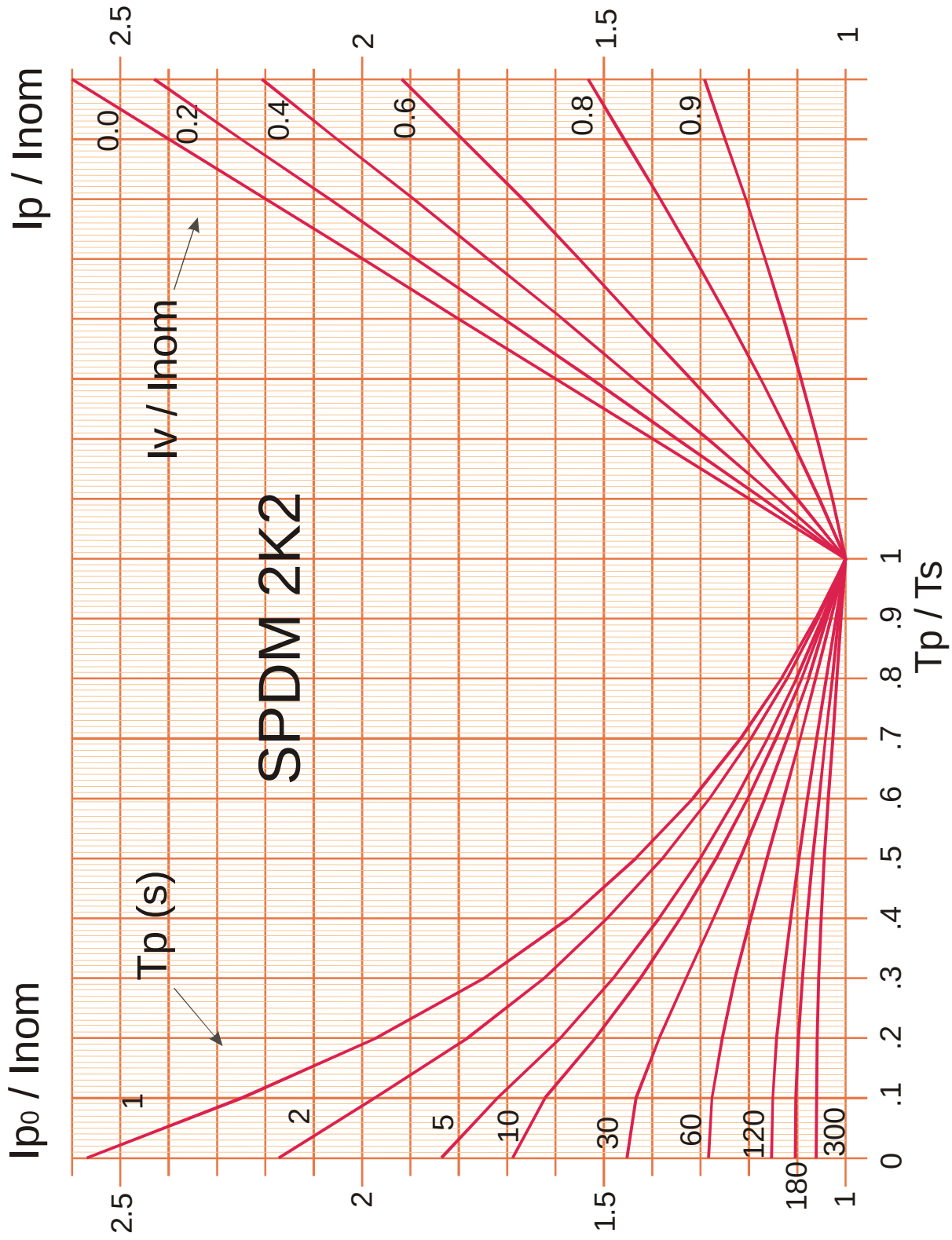

SPDM 1M0-1M1
Ip / Inom
Iv / Inom
Tp (s)
Ip0 / Inom
Tp / Ts
0.0
0.2
0.4
0.6
0.8
0.9
1
2
5
10
30
60
120
180
300
2.5
2
1.5
1
0
.1
.2
.3
.4
.5
.6
.7
.8
.9

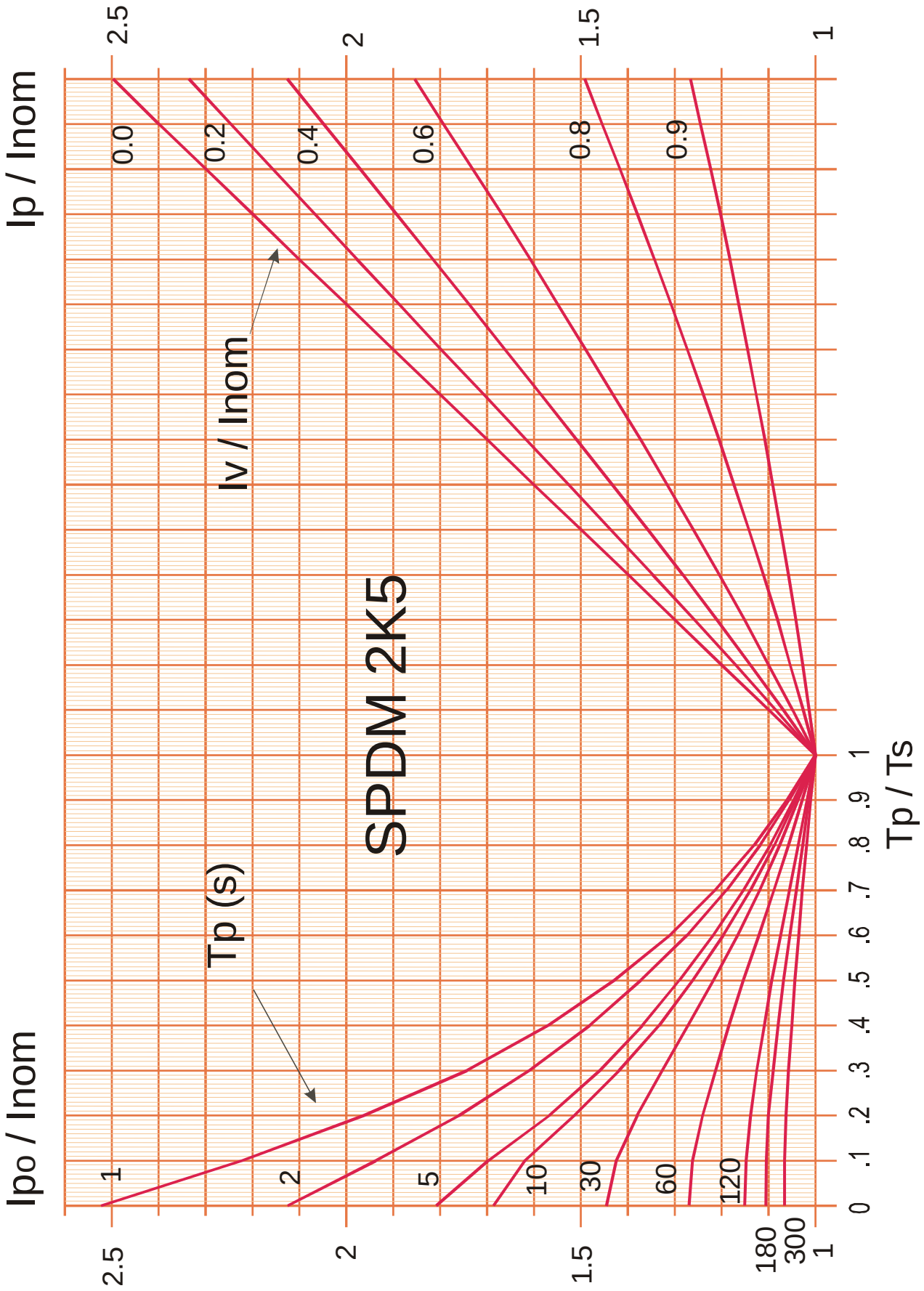

Ip / Inom
Iv / Inom
0.0
0.2
0.4
0.6
0.8
0.9
SPDM 1K5
Tp (s)
1
2
5
10
30
60
120
180
300
Ip0 / Inom
Tp / Ts
2.5
2
1.5
1
0
.1
.2
.3
.4
.5
.6
.7
.8
.9

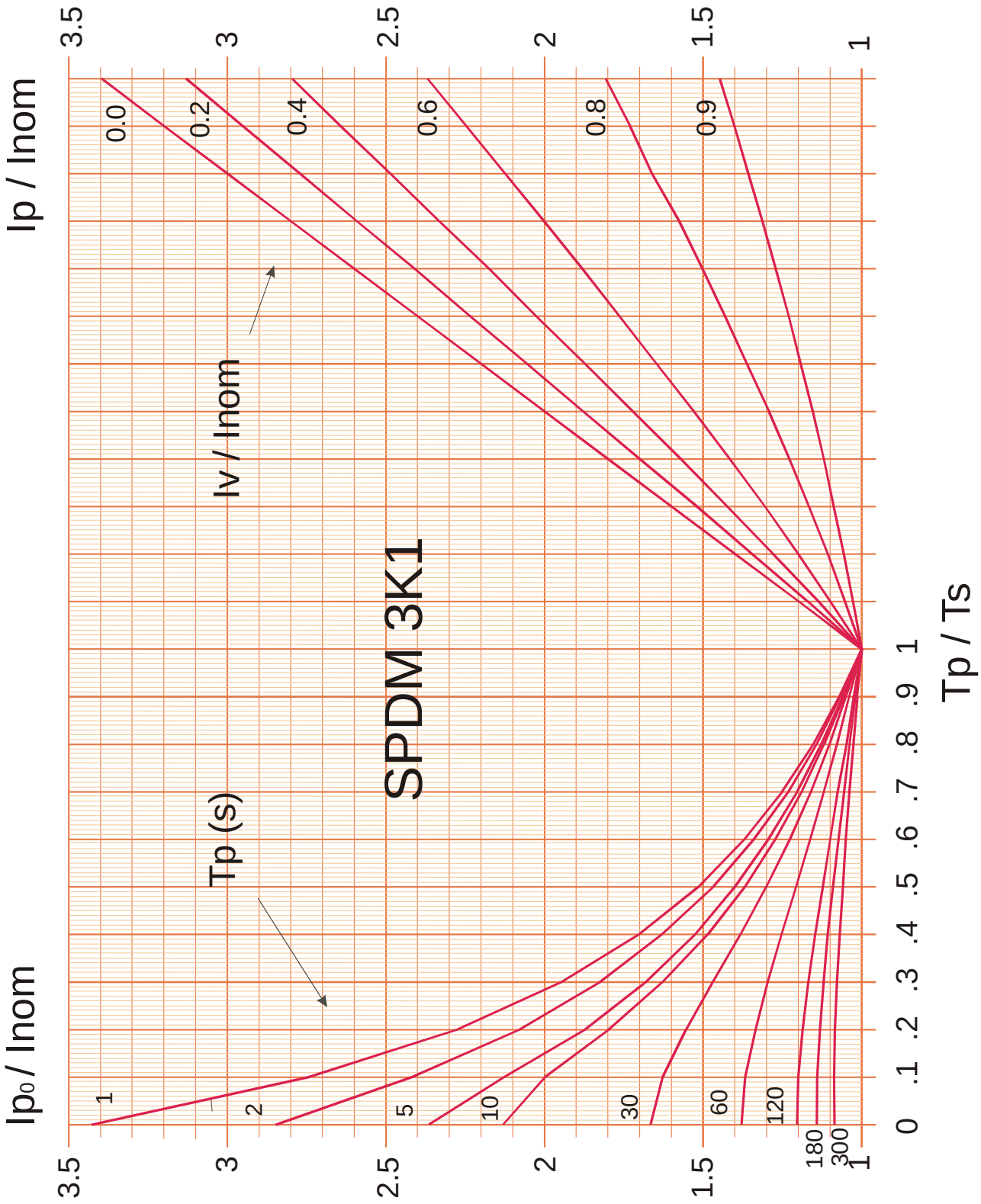

Ip / Inom
Iv / Inom
0.0
0.2
0.4
0.6
0.8
0.9
SPDM 1K6
Tp (s)
1
2
5
10
30
60
120
180
300
Ip0 / Inom
2.5
2
1.5
1
0 .1 .2 .3 .4 .5 .6 .7 .8 .9 1
Tp / Ts

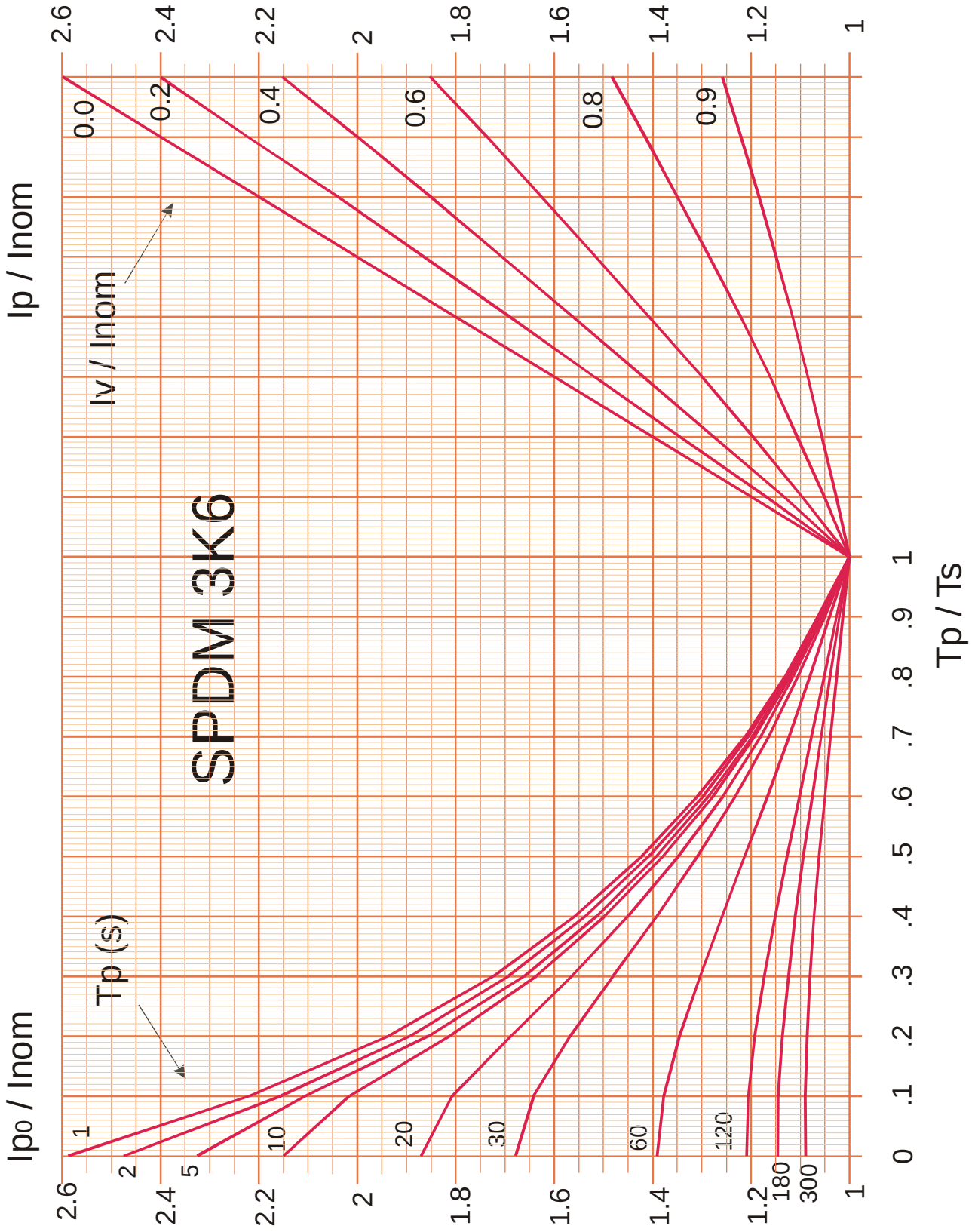

Ip / Inom
Iv / Inom
0.0
0.2
0.4
0.6
0.8
0.9
SPDM 1K7
Tp (s)
1
2
5
10
30
60
120
180
300
Ip0 / Inom
Tp / Ts
3.5
3
2.5
2
1.5
1
0 .1 .2 .3 .4 .5 .6 .7 .8 .9 1

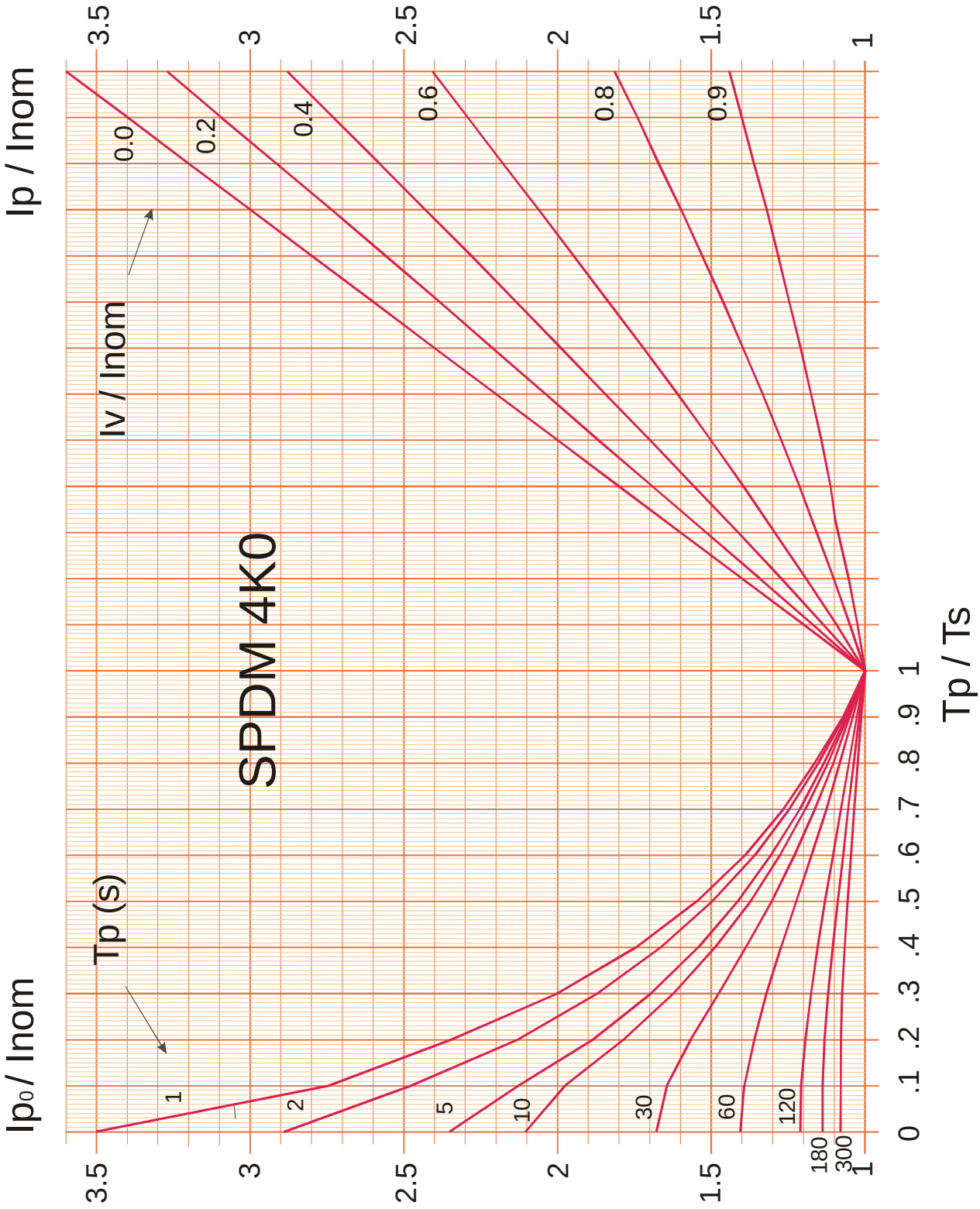

SPDM 2K1
Ip / Inom
Iv / Inom
Ip0 / Inom
Tp / Ts
Tp (s)
0.0
0.2
0.4
0.6
0.8
0.9
1
2
5
10
30
60
120
180
300
3.5
3
2.5
2
1.5
1
0 .1 .2 .3 .4 .5 .6 .7 .8 .9 1


Ip / Inom
Iv / Inom
0.0
0.2
0.4
0.6
0.8
0.9
SPDM 2K2
Tp (s)
1
2
5
10
30
60
120
180
300
Ip0 / Inom
Tp / Ts
2.5
2
1.5
1
0
.1
.2
.3
.4
.5
.6
.7
.8
.9


Ip / Inom
Iv / Inom
Tp (s)
SPDM 2K5
Ipo / Inom
Tp / Ts
2.5
2
1.5
1
0.0
0.2
0.4
0.6
0.8
0.9
1
2
5
10
30
60
120
180
300
0 .1 .2 .3 .4 .5 .6 .7 .8 .9 1


Ip / Inom
Ip0 / Inom
Tp / Ts
Iv / Inom
Tp (s)
SPDM 3K1
0.0
0.2
0.4
0.6
0.8
0.9
1
2
5
10
30
60
120
180
300
3.5
3
2.5
2
1.5
1
0 .1 .2 .3 .4 .5 .6 .7 .8 .9 1


SPDM 3K6
Ip / Inom
Iv / Inom
0.0
0.2
0.4
0.6
0.8
0.9
Ip0 / Inom
Tp (s)
1
2
5
10
20
30
60
120
180
300
Tp / Ts
2.6
2.4
2.2
2
1.8
1.6
1.4
1.2
1
0
.1
.2
.3
.4
.5
.6
.7
.8
.9


Ip / Inom
Iv / Inom
0.0
0.2
0.4
0.6
0.8
0.9
SPDM 4K0
Tp (s)
1
2
5
10
30
60
120
180
300
Ip0 / Inom
Tp / Ts
3.5
3
2.5
2
1.5
1
0 .1 .2 .3 .4 .5 .6 .7 .8 .9 1

A9 HARDWARE OPTIONS

Silcopac D converter may be equipped with optional boards that are mounted inside the drive, on request, or sold in kit including the accessories needed to the installation inside the converter and to their customizing.

A9.1 SPAE 0 Static field rectifier

It must be installed inside the converter mounting it on the upper cover by means of the proper accessories as described for the last version of SPAE1 exciter (SPAE1A).

It is connected to the Silcopac D control circuits by a flat cable to X11 connector on P board, by which it receives the power supply for its electronics components and to which sends the field current presence signal monitored by the field loss protection. Disable the E.M.F. regulator (par. 2.6.4 section C) setting CCA parameter to OFF.

Set the field loss protection threshold to 50% programming the parameter DC3=50.

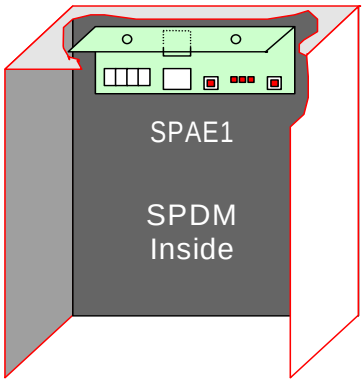
Power supply $VAC_{Max} \leq 415$ V	Output voltage $VDC_{Max} <$ VAC x 0,9	
Rated output current $If_{Max} =$ 10 A		
The field current adjustment must be performed with an external resistor placed in series to the field and according to the following parameters:		
$R(\Omega) = (VCC_{Max} - VF) / If$	where: VF = field voltage at rated field current	
$P(watt) = R\ If^2$		

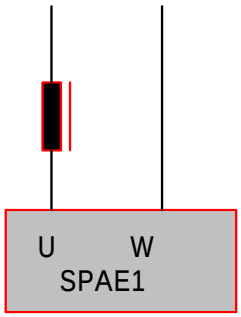
A9.2 SPAE 1 Semi-controlled exciter

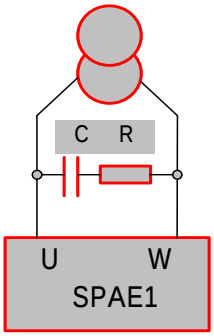
The SPAE1 exciter is mounted on the Silcopac D fixing it down at the drive top cover using an angle iron that is part of the radiant heat surface. At the end of the mounting operations the board is in front view.

It is connected to the Silcopac D control circuits by a flat cable from K11 connector on the exciter to X11 connector on P board.

Power supply $VAC_{Max} \leq 415$ V	Output voltage $VDC_{Max} <$ VDC x 0,81	
Rated output current $If_{Max} =$ 10 A		
N.B. 1) In case of direct power supply from network, it requires a decoupling reactor. 2) In case of power supply from transformer, it requires RC filter.		







R = 30Ω 100W
C = 4μF 450V

For SPAE1 exciter customizing, refer to par. 2.5 section C.

A9.3 SPDIO

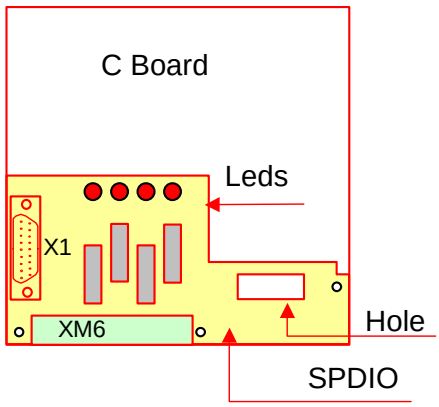
Logic I/O expansion board

This board provides four additional opto-coupled logic inputs (7 total inputs: COM1 to COM7) and four additional logic relay outputs (6 total outputs: OUT1 to OUT6).
The board is installed inside the converter overlapping it on the lower edge of C board by means of the proper accessories and paying attention to insert the SPDIO connector into the X1 connector (15 pins) of C board.
This board is normally used in applications requiring some optional software functions.
The meaning of the four relay output (OUT3 to OUT6) can be set through DO3 to DO6 parameters (see section B of this manual).
The ogic input are opto-coupled and their current consumption is 8mA.

XM6 teminal block:	Description
1-2	COM4 logic input; connecting these two terminals to +24V power supply (terminal 2 = 0V), the input will be enabled.
3-4	COM5 logic input:connecting these two terminals to +24V power supply (terminal 4 = 0v), the input will be enabled.
5-6	COM6 logic input; connecting these two terminals to +24V power supply (terminal 6 = 0v), the input will be enabled.
7-8	COM7 logic input;connecting these two terminals to +24V power supply (terminal 8 = 0v), the input will be enabled.
9-10-11	OUT3 relay contacts; 220V, 2A; terminal 9: common; terminal 10: N.A. contact; terminal 11: N.C.contact.
12-13-14	OUT4 relay contacts; 220V, 2A; terminal 12: common; terminal 13: N.A. contact; terminal 14: N.C. contact.
15-16-17	OUT5 relay contacts; 220V, 2A; terminal 15: common; terminal 16: N.A. contact; terminal 17: N.C. contact.
18-19-20	OUT6 relay contacts; 220V, 2A; terminal 18: common; terminal 19: N.A contact; terminal 20: N.C. contact.
21	External 0V.

On SPDIO board four leds (E1, E2, E3 , E4) show the status of the four output OUT3, OUT4, OUT5 ed OUT6 (they are ON when the related output is energized).





A9.4 "SUPRB" Profibus board

The Profibus board "SUPRB" is supplied with the mounting kit Profibus SPPB2. The kit, in addition to the board, contains the mounting accessories.

Profibus DP option board technical data

Profibus DP connections	Interface	SUPRB: 9-pin DSUB connector (female)
	Code	ELC45248701
	Data transfer method	RS-485, half-duplex
	Transfer cable	Twisted pair (1 pair and shield)
	Electrical isolation	500 VDC
Communications	Profibus DP	As described in document "Profibus Profile for variable speed drives"
	PPO types	1, 2, 3, 4, 5
	Baud rate	9.6 kbaud to 12 Mbaud
	Addresses	2 to 126
Environment	Ambient operating temperature	-10°C - 55°C
	Storing temperature	-10°C - 60°C
	Humidity	<95%, no condensation allowed
	Altitude	Max. 1000 m
	Vibration	0.5 G at 9 - 200 Hz
Safety		Fulfils EN50178 Standard

A9.4.1 Profibus cable

Profibus devices are connected in a bus structure. Up to 32 stations (master or slaves) can be connected in one segment. The bus is terminated by an active bus terminator at the beginning and end of each segment. To ensure error-free operation, both bus terminations must always be powered. When more than 32 stations are used, repeaters (line amplifiers) must be used to connect the individual bus segments. The maximum cable length depends on the transmission speed and cable type.
The specified cable length can be increased using the repeaters. The use of more than 3 repeaters in series is not recommended.

Table A9.5.1 Line parameters

Parameter	Linea A	Linea B
Impedance	135 ... 165 (3 to 20 Mhz)	100 ... 130 (f > 100kHz)
Capacity	< 30 pF/m	< 60 pF/m
Resistance	< 110 / km	-
Wire gauge	> 0,64 mm	> 0,53 mm
Conductor area	> 0,34 mm2	> 0,22 mm2

PROFIBUS Cable and connector

TYPE	SAP CODE
CONNECTOR 9P	ELC226056
CABLE	ELC226058 o 229306
E.g. following cables can be used:	Belden Profibus Data Cable 3079A
	Siemens SINEC L2 LAN cable for Profibus 6XV1 830-0AH10

WARNING Use strictly the connector shown in the upper table (see also figure on the next page).

A9.4.2 Profibus fieldbus connections

Bus connector signals

Profibus Fieldbus Board is connected to the fieldbus through a 9-pin female sub-D-connector (X1). The communication with the control board takes place through the standard GT3000 Interface Board Connector K4.	Signal	Connector X1 (pin)	Description
	Shield	1	Cable shield
	VP	6	Supply voltage – plus (5V)
	RxD/TxD-P	3	Receive/Transmit data - plus (B)
	RxD/TxD-N	8	Receive/ Transmit data - minus (A)
	DGND	5	Data Ground (reference potential for VP)

The figure 9.5.1 shows Profibus connector and underlines the switch that inserts the termination resistor of the last line slave.
To guaranty the continuity of the shield put the same on metallic connector (see. 2).
The slave cable connection must be always inserted on the left side of internal screw terminal board in respect of colours sequence.

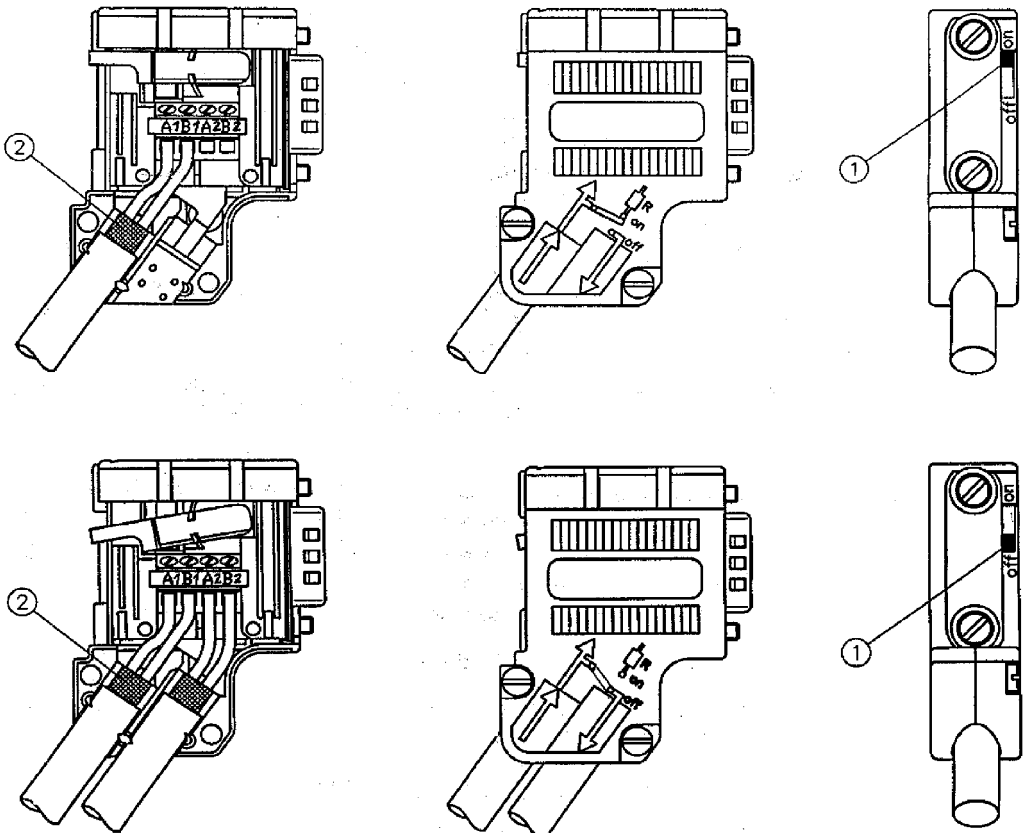
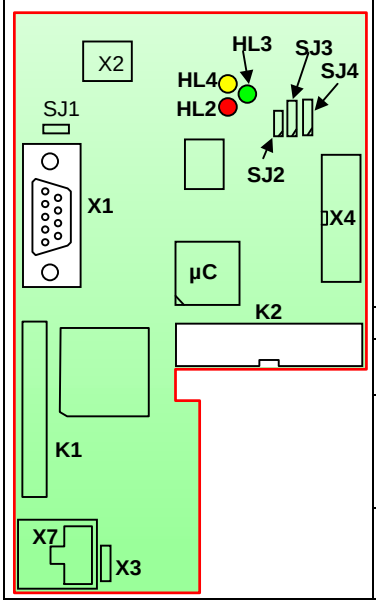


Figure 9. 4.1 Connector for Profibus board

A9.4.3 Board Layout and LED



SJ1	Opened
SJ2	Opened
SJ3	Closed on 2-3
SJ4	Opened
K1	Connector for connection to microprocessor board "C" (X6 connector).
X1	Profibus connector
X2	Not used
X3	Reserved
X4	Not used
X7	Not used

LED:	STATUS:	MEANING:
HL3 Green	ON	Fieldbus module is waiting for parameters from the frequency converter - No external communication
HL2 Red	ON	Profibus communicates normally. - Data exchange between Master and Slave
	OFF	Profibus communication is broken or not started, Bus cable broken or incorrectly connected, Wrong configuration or parametrization data of Master, Master is off line or shut down
HL4 Jellow	ON	Fieldbus Module is activated, - Parameters received and module activated, - Module is waiting for messages from the bus
	OFF	Option board not activated

WARNING

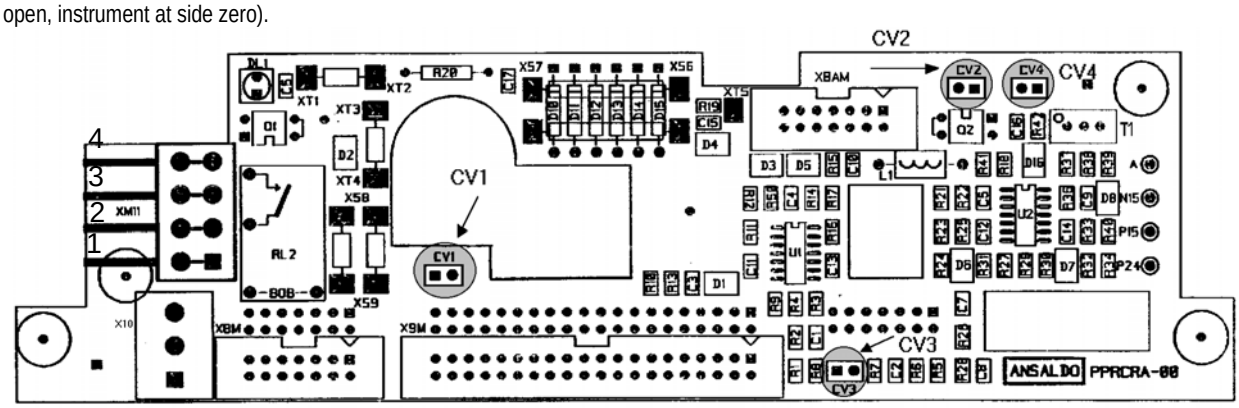
Device DP profile is defined through a GSD file (Device Database File), supplied by device manufacturer.

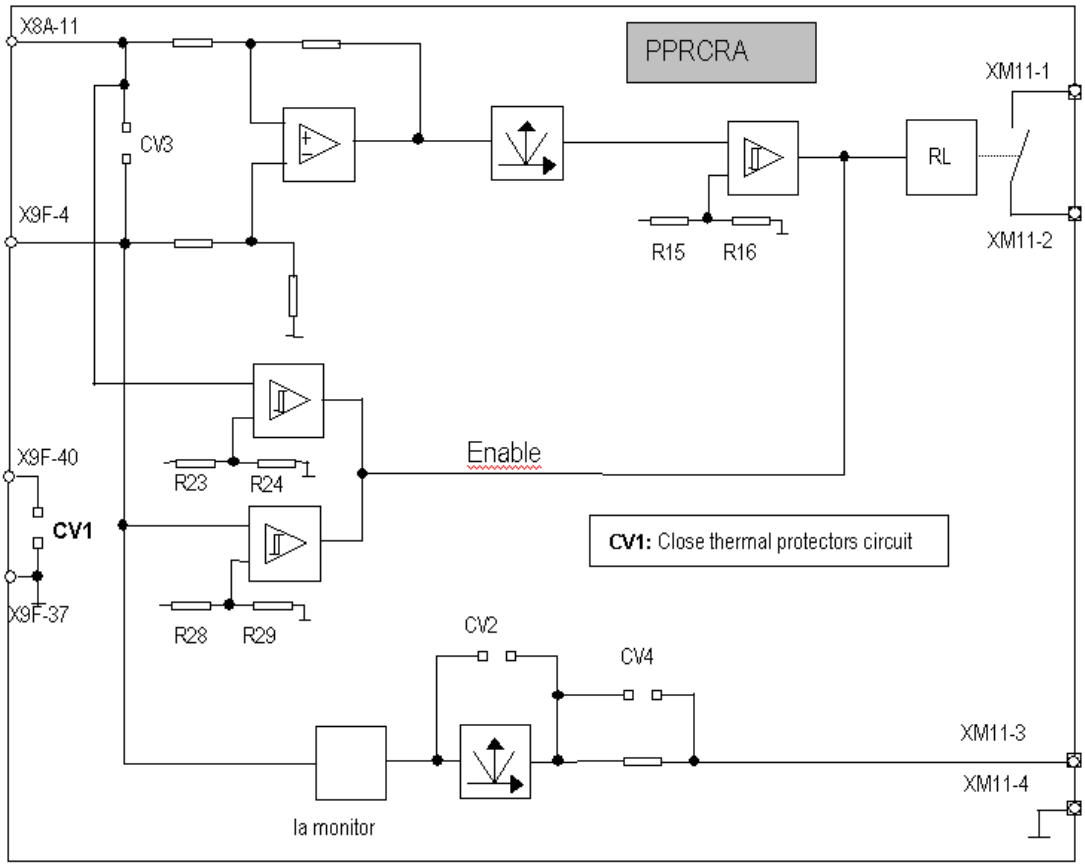
A9.5 PPRCRC BOARD.

A9.5.1 Description of the PPRCRA board

The PPRCRC board is installed inside the master converter in the parallel bridges application.
The board compares the IAM current delivered from the MASTER (SPDM) with the current delivered by the SLAVE (RTT). If the difference between the two currents exceeds the permitted tolerance, the relay RL drops out.
The protection will be disabled until the current of a bridge reaches its rated value.
The board is fitted onto the P board by means of the relevant connectors and spacers.
The C board of the SPDM will no longer be connected to the P board, but to the PPRCRC board through the connectors which keep the same codes as before.

On the board, the circuit of the Ia monitor of the RTT module is present with outlet at the Faston terminals XM 11-3,4. A milliammeter may be connected to these terminals in d.c. current with 5 mA limit or a d.c. voltmeter with 10 V limit. The output can be set with the T1 trimmer.
Should a voltmeter be used, the CV4 jumper must be closed.
The output from the Ia monitor can be at a relative value (CV2 jumper closed, instrument at central zero) or at absolute value (CV2 open, instrument at side zero).





A10 OPTIONS AND FUNCTIONS

10.1 Interface

Silcopac D digital converter is equipped with a device which manages the exchange of information and data with the external world by means of a serial link.

It is possible to carry out a point-to-point connection by means of a RS 232 electric standard device.

Use the proper serial communication software to link a personal computer by a point-to point connection to set parameters and carry out diagnostic operations specifically concerning the converter start-up and troubleshooting. This type of connection does not require any additional hardware (Fig. A10.1).

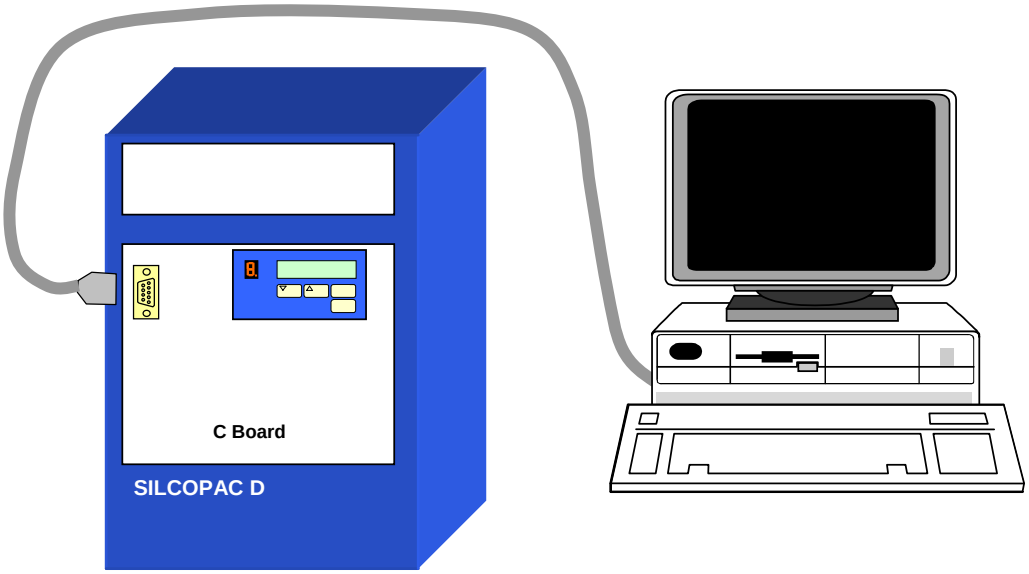


Figure A10.1

A10.2 List of auxiliary functions

1 Helper: it used to pilot a Silcopac D starter under current keeping the speed regulator in its saturation status.
2 Pope: it is used to adjust a tangent winder to a fixed and re-calibrable current reference obtained by the speed regulator.
3 Mechanical friction compensation: it is used to compensate static and dynamic mechanical friction of the cinematic chain which connects the motor.
4 Torque Proof: it is usually used in lifting system to check the actual application of the traction torque before opening the brake.
5 Load weighting: it is usually used in lifting systems with de-fluxed motor to re-calibrate the lifting speed as function of the possibility to overload the motor.
6 Gain re-calibration as function of the flux function: it is used in the applications with speed regulation with defluxed motor to keep the regulator bandwidth constant for the whole speed interval.
7 Speed reaction commutation: it is used to guarantee the speed regulation of a motor also in case of speed reaction loss (encoder or tacho loss), switching to the armature voltage regulation (only with not defluxed motors).
8 Motopotentiometer: it is used to generate an internal speed reference which can be changed by means of increase and decrease commands.
9 Internal references: are used to set fixed internal speed references (slow runs, etc.).
10 Changeable parameters: this function is used to double the sets of available parameters for the regulators calibration, for internal references and for the ramps.
11 Field inversion: this function is used to manage the reversibility with a one-direction starter, controlling a reversible energizer.
12 Fast re-start: this function is used to manage the system re-start after a power failure.
13 Speed error: it informs that the system is not controlling the motor speed.
14 Tacho loss: allows to set the threshold of armature voltage above which the intervention of the “tachometer loss” protection (TachF) is enabled.
15 races: The DRIVE TRACE and the THYRISTOR TRACE can be blocked also by the external logic input COM2.
16 Diagnostic variables: The auxiliary variables Aux1, Aux2 and Aux3 can be customized to display the power provided by the axis of the motor (in % compared to the rated power).
17 Double set complete of parameters: The function allows to store in memory two complete set of parameters. (as in the typical case of a winder whose configuration must be changed according to the material wound up).
18 Personal Password: The user can use a personal password.
19 Toggling of the references and commands: allows to toggle either the speed reference from Motopotentiometer to terminal board (input Ref XM1-33, XM1-34) and the contrary; or from serial line to input ‘Rif’. through the logic input COM4 (terminal XM6-1, XM6-2, I/O expansion board “SPDIO”).

A10.3 List of enhanced functions

1 Angular positioning regulator: it is used to position the drive shaft.
2 Inertia compensation: it used to compensate the load inertias: constant or variable inertias as in the case of winders/unwinders.
3 Mechanical backlash compensation: it is used to reduce the opening effect of mechanical backlash of the cinematic chain connecting the motor (for ex. reducers, couplers, etc.).
4 Angular speed as function of the diameter: it is used to re-calibrate the angular speed according to the value of the diameter to keep the linear speed constant.
5 Tension regulator: it is a PID regulator which can adjust the speed reference or impose a current reference. It compares the set reference with the reaction coming from the transducer (load cell, dandy roll, etc.).
6 Winder: open loop tension regulators for torque adjusted axial or tangent winders/unwinders

A10.4 List of dedicated functions

1) Accurate speed ratio: for the speed regulation of a small line (up to 6 motors) with automatic management of sliding devices of each section.
2) Spindle: for the control of spindle machines.
3) Ward Leonard: for the control of Ward Leonard machines and digital exciters.

A10.5 RESOURCES USE

With the resources term, we mean the set of logic inputs, analog inputs and available functions for the configuration of drive-motor machine system.

The parameters management supervises the programming of the new values so to avoid that a resource is used for more than one function. The control warns the user of the error showing, on the user interface, the message: CONSISTENCY ERROR (paragraphs B1.1 - B1.2 - B1.3).

A10.5.1 SUMMARY OF ANALOG INPUTS USE

Analog input Rif (terminals XM1-33, 34)

- Armature current reference (parameter CA1).
- Speed reference (parameter CB1).
- Speed reference with polarity imposed by logic input Com3 (parameter CB1).
- Speed reference with polarity imposed by logic inputs Com1 e Com2 scheme (parameter CB1).
- Speed reference commutated with motopotentiometer function by logic input COM4 (parameter CB1).
- Tension reference (parameter CJ1)

Analog input Ean1 (terminals XM1-29, 31)

- Armature current reference (parameter CA1).
- Armature current upper limit (+ Ean1) and lower limit (- Ean1) (parameter CA2).
- Armature current upper limit (+ Ean1) and lower limit (- Ean1) imposed by logic input Com3 (parameter CA2).
- Armature current upper limit (CA2).
- Adding term to armature current reference (parameter CA3).
- Helper function: Armature current reference for load sharing (parameter CEA).
- Diameter origin selection (parameter CN6).
- Tension reference (parameter CJ1)
- Starting diameter origin selection (parameter CN2).

Analog input Ean2 (terminals XM1-30, 31)

- Armature current reference (parameter CA1).
- Armature current lower limit (CA2).
- Adding term to the armature current reference (parameter CA3).
- Adding term to the armature current reference imposed by logic input Com3 (parameter CA3).
- Adding term to the speed reference (parameter CB2).
- Adding term to the speed reference imposed by logic input Com3 (parameter CB2).
- Diameter origin selection (parameter CN6).
- Tension feedback origin selection (parameter CJ2)
- Starting diameter origin selection (parameter CN2).
- Material densty origin selection (parameter CM2).
- Material width origin selection (parameter CM3).

Analog input If (terminals XM1-28, 31)

Field current feedback (jumper JP25 – par. 7.1 sect.A – par. 2.6.1 sect.C).

- Funzione di inversione del campo (vedere funzione)
- Selezione della provenienza del segnale densità del materiale (parameter CM2).
- Material width value origin selection (parameter CM3).

Analog input Tach (terminals XM1-26, 27)

- Speed feedback origin selection (parameter CB3).
- Tension feedback origin selection (parameter CJ2).
- Material width origin selection (parameter CM3).

A10.5.2 SUMMARY OF LOGIC INPUT USE

Logic input Com1 (terminal XM1-17)

- Motopotentiometer function: Increase of the speed reference (parameter CB1).
- Motopotentiometer function: Increase of the speed reference with polarity imposed by logic input COM3 (parameter CB1).
- Motopotentiometer function: Increase of the speed reference with commutation of the analog input Rif imposed by logic input COM4 (parameter CB1)
- Speed reference polarity if that comes from analog input Rif, with digital input COM2 (parameter CA1).
- Helper function: Increase the parameter DJ3 value to do the load sharing.
- Pope function: Increase the memorized current reference value to increase the tension.
- Diameter acquisition.
- Exchange of parameters exchange during the reset of the converter.

Logic input Com2 (terminal XM1-18)

- Motopotentiometer function: Reduction of the speed reference (parameter CB1).
- Motopotentiometer function: Reduction of the speed reference with polarity imposed by logic input COM3 (parameter CB1).
- Motopotentiometer function: Reduction of the speed reference with commutation of the analog input Rif imposed by logic input COM4 (parameter CB1)
- Speed reference polarity if that comes from analog input Rif, with digital input COM1 (parameter CA1).
- Helper function: Reduce the parameter DJ3 value to do the load sharing.
- Pope function: Reduce the memorized current reference value to increase the tension.
- Angular position regulator enabling.
- Starting diameter acquisition.
- Drive trace and thyristor trace stopping.

Logic input Com3 (terminal XM1-19)

- Speed reference polarity with speed reference from the motopotentiometer (parameter CB1).
- Speed reference polarity with speed reference from the analog input Rif (parameter CB1).
- Enabling of armature current limit from analog input Ean1 (parameter CA2).
- Enabling of the adding term to current reference from analog input Ean2 (parameter CA2).
- Enabling of the adding term to speed reference from analog input Ean2 (parameter CB2).
- Helper function enabling.
- Pope function enabling.
- Torque proof and/or Load weighting function enabling
- Changeable parameters exchange.
- Switching of speed feedback from tacho generator/encoder to armature voltage.
- Tension loop function enabling.

Logic input COM4 (terminals **XM6-1 e XM6-2 SPDIO expansion board).**

- Commutation from analog input Rif to motopotentiometer (parameter CB1).

Logic input COM5 (terminals **XM6-3 e XM6-4 SPDIO expansion board).**

Logic input COM6 (terminals **XM6-5 e XM6-6 SPDIO expansion board).**

- Zero speed tension acquisition
- Field inversion function.

Logic input COM7 (terminals **XM6-7 e XM6-8 SPDIO expansion board).**

- Zero speed tension acquisition
- Field inversion function.

A11 SPARES

To minimize the converter down time required for repair, it is suggested to stock a suitable amount of spare parts (especially concerning those components not directly available from supply stores). The following tables show a suggested spare parts list and their relevant part number for a Silcopac D converter.

A11.1 Control electronic circuits				
CODE		DESCRIPTION		SUGGESTED Q.TY.
ELC45244601	CONDB	The SW installed is the upgraded version. If the original SW is different, it's necessary to change the new EPROM with the old one mounted in the broken broad		1
		POWER CARD		
ELC260580	PU 50A	II QUADRANT 380V/500V D-G		1
1000073024	PU 66A	II QUADRANT 600V/690V H-K		1
ELC260561	PR 50A	IV QUADRANT 380V/500V D-G		1
ELC260562	PR 66A	IV QUADRANT 600V/690V H-K		1
1000002327	PU 85A	II QUADRANT 750/850V W-M		1
ELC452445	PR 85A	IV QUADRANT 750/850V W-M		1
ELC452567	PU1KA	II QUADRANT 950V N		1
ELC452463	PR1KA	IV QUADRANT 950V N		1
A11.2 Snubbers				
1000000453	FR.I	SPDM G	BOARD FI60A 380V - 500V	1
1000000455	FR.II÷IIIL	SPDM G	BOARD FI60B 380V - 500V	1
ELC262347	FR.I	SPDM H-K	BOARD FI75A 600V ÷ 750V	1
1000000456	FR.II÷IIILL	SPDM H-K-W	BOARD FI75B 600V ÷ 750V	1
ELC28510601	FR.IV-V	SPDM G-H	SNUBBER T IV 690V	1
ELC22110401	FR.IV-V	SPDM K-W-M-N	RESISTOR.. 33 ohm	1
ELC20545904	FR.IV-V	SPDM…K-W-M-N	CAPACITOR 1μF 1200V	1

A11.3 Fan			
ELC206308	II	220V 1F/1PH 50/60HZ	1
ELC206307	III	220V 1F/1PH 50/60HZ	1
ELC206480	IIIL-IIILL	380V/440V 3F/3PH 50/60HZ	1
ELC206407	IV	380V/440V 3F/3PH 50/60HZ	1
ELC220199	⦿ Version 1	380V/440V 3F/3PH 50/60HZ	1
1000001666	⦿ Version 2 (SPDM 4K0..K/W and SPDM with suffix 50)	400V/460V 3F/3PH 50/60HZ	1

A11.4 Options		
Type	Code	Description
SPDIO	ELC25908304	Digitals I/O Expansion
SPDI1	ELC25908301	Keypad
SPDI2	ELC28730316	Keypad (Without Cables)
SPDS1	ELC25908306	Serial Link RS485
SPPB	ELC406681	Profibus Board
PPRCRA (RTT)	ELC452241	Parallel Bridge Board
PPRCRB	ELC452242	Parallel Bridge Board
AL24	ELC420166	External Power Supply
SPAEO (10A)	ELC25908820	Internal Field Bridge
SPAE1 (10A)	ELC25908821	Internal Field Regulator
ATRS22 ATRS50	ELC206698 ELC204699	Synchronism Autotransformer

⦿ It is offered the fan without the holder. See page 17

A11.5 U.F. fuses

External Fuses

2 Quadrant	Mains Voltage	AC Fuses ❶
SPDM030UG	400V	ELC20653301
SPDM030UG	500V	ELC20653301
SPDM030UH	600V	ELC20653301
SPDM600UG	400V	ELC20653302
SPDM600UG	500V	ELC20653302
SPDM600UH	600V	ELC20653302
SPDM080UG	400V	ELC20653303
SPDM080UG	500V	ELC20653303
SPDM080UH	600V	ELC20653303
SPDM110UG	400V	ELC20653304
SPDM110UG	500V	ELC20653304
SPDM110UH	600V	ELC20653304
SPDM160UG	400V	ELC20653306
SPDM160UG	500V	ELC20653306
SPDM160UH	600V	ELC20653306
SPDM200UG	400V	ELC21242801
SPDM200UG	500V	ELC21242801
SPDM200UH	600V	ELC21242801
SPDM260UG	400V	ELC21242802
SPDM260UG	500V	ELC21242802
SPDM260UH	600V	ELC21242802
SPDM350UG	400V	ELC21242803
SPDM350UG	500V	ELC21242803
SPDM350UH	600V	ELC21242803
SPDM450UG	400V	ELC21242804
SPDM450UG	500V	ELC21242804
SPDM350UH	600V	ELC21242804
SPDM500UK	690V	ELC21242805
SPDM600UG	400V	ELC21242806
SPDM600UG	500V	ELC21242806
SPDM600UH	600V	ELC21242806

4 Quadrant	Mains Voltage	AC Fuses❶ *	DC Fuses❶ **
SPDM030RG	400V	ELC20653301	ELC20653301
SPDM030RG	500V	ELC20653401	ELC20653401
SPDM030RH	600V	ELC20653401	ELC20653401
SPDM060RG	400V	ELC20653302	ELC20653303
SPDM060RG	500V	ELC20653402	ELC20653403
SPDM060RH	600V	ELC20653402	ELC20653403
SPDM080RG	400V	ELC20653303	ELC20653304
SPDM080RG	500V	ELC20653403	ELC20653404
SPDM080RH	600V	ELC20653403	ELC20653404
SPDM110RG	400V	ELC20653304	ELC20653305
SPDM110RG	500V	ELC20653404	ELC20653405
SPDM110RH	600V	ELC20653404	ELC20653405
SPDM160RG	400V	ELC20653306	ELC21242801
SPDM160RG	500V	ELC20653406	ELC21242901
SPDM160RH	600V	ELC20653406	ELC21242901
SPDM200RG	400V	ELC21242801	ELC21242801
SPDM200RG	500V	ELC21242901	ELC21242901
SPDM200RH	600V	ELC21242901	ELC21242901
SPDM260RG	400V	ELC21242802	ELC21242803
SPDM260RG	500V	1000094223	ELP21242903
SPDM260RH	600V	1000094223	ELP21242903
SPDM350RG	400V	ELC21242803	ELC21242804
SPDM350RG	500V	ELP21242903	ELC407417
SPDM350RH	600V	ELP21242903	ELC407417
SPDM450RG	400V	ELC21242804	ELC21242805
SPDM450RG	500	ELC40803808	ELC40803804
SPDM350RH	600V	ELC40803808	ELC40803804
SPDM500RK	690V	ELC40803803	ELC40803804
SPDM600RG	400V	ELC21242806	ELC21242807
SPDM600RG	500V	ELC40803804	ELC40803806
SPDM600RH	600V	ELC40803804	ELC40803806

❶	690 V	1000 V

* Adviced quantity: 3
** Adviced quantity: 2

Internal Fuses			
Silcopac D	Fuses		
	Size	Code	Adviced quantity
SPDM750 RK	500A/1000V	ELC20652702	4
SPDM850 UD-UG-RD	550A/690V	ELC20648501	4
SPDM850 UK-RH	550A/1000V	ELC20652701	4
SPDM850 RG	550A/1000V	ELC20648401	4
* SPDM1K1UD-G-H RD	700A/690V	ELC20648503	4
* SPDM1K1 RG-H	700A/1000V	ELC20648403	4
* SPDM1K2	750A 1000V	ELC21981101	4
SPDM1M0UG	700A/1000V	ELC20648403	4
SPDM1M1 UG-UH	750A 1000V	ELC21981101	4
SPDM1M1 RG-RH	750A 1000V	ELC21981101	4
SPDM1K5 UK-RK	1000A/1000V	ELC20534903	4
SPDM1K5 UW-RW	900A/1250V	ELC40781601	4
SPDM1K5 N-M			4
SPDM1K6 UD-UG-RD	1100A/690V	ELC20652801	4
SPDM1K6 RG	1100A/1000V	ELC206526	4
SPDM1K7 UK	1100A/1000V	ELC206526	4
SPDM1K7 RK-RW-UW	1100A/1250V	ELC20650001	4
SPDM1K7 N-M			4
SPDM2K1 UD-UG-RD	1400A/690V	ELC20652803	4
SPDM2K1 RG	1400A/1100V	ELC20652402	4
SPDM2K2 K-W	2X700A/1250V	ELC22073306	4
SPDM2K2 N-M			4
SPDM2K5 UD-RD-UG	2x800A/690V	ELC22152207	4
SPDM2K5 UK-RG	2x800A/1250V	ELC22073307	4
SPDM2K5 RK-UW-RW	2x800A/1250V	ELC22007401	4
SPDM3K1 UD-RD-UG	2X1000A/690V	ELC22152008	4
SPDM3K1 RG-UK-RK-UW	2X1000A/1250V	ELC22007404	4
SPDM3K1 RW	2X900A/1250V	ELC22007402	4
SPDM3K1 N-M			4
SPDM3K6 UD-RD-UG	2X1250A/690V	ELC22152006	4
SPDM3K6 RG-UK-RK-UW	2X1100A/1250V	ELC22007403	4
SPDM3K6 N-M	2X1100A/1250V	ELC22007403	4
SDM4K0UG	2×1400A/1250V	ELC22007406	4
SDM4K0RG	2×1400A/1250V	ELC22007406	4
SPDM4K0U/RW	2×1250A/1250V	ELC22007405	4

* No more available (superseded)

A11.6 THYRISTORS			
Silcopac D	Thyristors		
	Type	Code	Adviced quantity
SPDM030 D-G	SKKT27/14E	ELC20636002	2
SPDM030 H	SKKT27/18E	ELC20636004	2
SPDM060-80 D-G	SKKT72/14E	ELC20636006	2
SPDM060-80 H	SKKT72/18E	ELC20636012	2
SPDM110 D-G	SKKT92/14E	ELC20636010	2
SPDM110 H	SKKT92/18E	ELC20636012	2
SPDM160-200 D-G	SKKT105/14E	ELC20648312	2
SPDM160-200 H	SKKT105/18E	ELC20648314	2
SPDM160 W	SKKT105/22E	ELC22083902	2
SPDM260 D-G	SKKT132/14E	ELC20636014	2
SPDM260 H	SKKT132/18E	ELC20636016	2
SPDM350–450 D-G	MCC162/14i 01	ELC20636018	2
SPDM350-450H	MCC162/18i 01	ELC20636020	2
SPDM500 K	SKKT210/20E	ELC20636025	2
SPDM500 W	SKKT210/22E	ELC20636026	2
SPDM600 D-G	SKKT250/14E	ELC20636028	2
SPDM600 H	SKKT250/18E	ELC20636030	2
SPDM750 K / 850UK	SKET330/22E	ELC20648306	2
SPDM850 D-G	SKET330/14E	ELC20648302	2
SPDM850 H	SKET330/18E	ELC20648304	2
* SPDM1K1D- G	SKET400/14E	ELC20648308	2
* SPDM1K1 H	SKET400/18E	ELC20648310	2
* SPDM1K2K	TT430N20K0F	ELC21980702	2
SPDM1M0 G	ATT571	1000008171	2
SPDM1M1 U/RG	TT500N (500A 1K6V)	ELC22253603	2
SPDM1M1 U/RH	TT500N (500A 2K0V)	ELC21980702	2
SPDM1K5 K	AT1007S22	ELC20281403	2
SPDM1K5 W	AT1007S24	ELC20281404	2
SPDM1K5 M-N			2
SPDM1K6 D-G	AT1004S16	ELC20052104	2
SPDM1K7 K / SPDM2K2K	AT655S20	ELC20565501	2
SPDM1K7 W / SPDM2K2W	AT655S24	ELC20565503	2
SPDM1K7 M-N / SPDM2K2M-N			2
SPDM2K1 D-G	AT636S16	ELC20559003	2
SPDM2K5 G	AT636S14	ELC20559002	2
SPDM2K5 K	AT655X20	ELC22203802	2
SPDM2K5 W	AT655X24	ELC22203803	2
SPDM2K5 M-N			2
SPDM3K1 G	AT737S14	ELC22164902	2
SPDM3K1 K	AT737S20	ELC22164904	2
SPDM3K1 W	AT847X24	ELC22109703	2
SPDM3K1 M-N			2
SPDM3K6 D-G	AT738S14	ELC40803102	2
SPDM3K6 K	AT738S20	ELC40803104	2
SPDM3K6 W	AT847LTS24X	ELC408029	2
SPDM3K6 M-N	AT847LTS26X	ELC408030	2
SPDM4K0 D	AT738LTS14X	ELC408028	2
SPDM4K0W	AT738LTS23	ELC40803503	2

* No more available (superseded)

B1 PARAMETERS

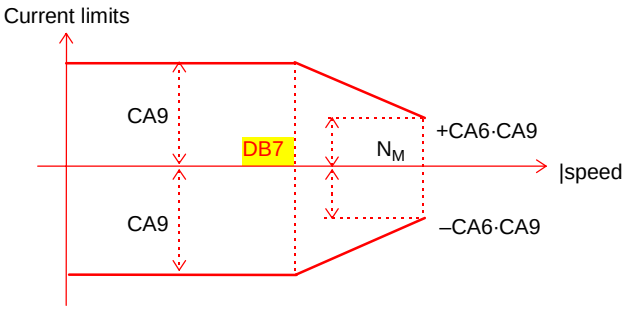
The final set-up of the converter is completed by assigning the proper value to every parameter through the user interface; however the parameters requiring adjustments by the user are often minimal, because many of them normally require the default value. Default value means a factory setting value (stored in the EPROM memory) that the system automatically acquire if the user doesn't insert a different value through the interface.
Grey shaded areas point out the most important parameters to be set or verified in the simplest applications.
The new parameters available with the new release EPROM 2.7 are pointed out in yellow.

NOTE

Below the name of every parameter there is is serial number and his image in memory (W=word, B=byte).
For the boolean parameters (ON/OFF) is indicated the bit inside his byte (exemple: CBB, 288.1 means that the parameter CBB is associated to the bit 1 of the byte with address 288). The bit numeration begins from 0 (least significative bit, LSB) till to 7 (more significative bit, MSB).
For the parameters expressed in % please note that the normalization factor is 13107 (3333 hex) so the value 100% meets to 13107 and –100% meets to 54429 (CCCD hex).
The enumerative parameters, that is these that have a selector function (for example CA1),takes values from 0 to N-1 where N is the selector position number.

B1.1 Configuration parameters

Code	Name	Default	Values	Description
Group A - CURRENT REG.				
CA1 258B	IaoSl	N_Reg		Selection of the armature current reference origin:
			N_Reg	From the speed regulator.
			Serial	From the serial link.
			Rif	From the differential analog input (terminals XM1-33, 34).
			Ean1	From the Ean1 analog input (terminals XM1-29).
			Ean2	From the Ean2 analog input (terminals XM1-30).
CA2 259B	IaoLm	Fixed		Selection of the armature current limits:
			Fixed	Upper limit: fixed by the TA3 (1st set) and TB3 (2nd set) parameters. Lower limit: fixed by the TA4 (1st set) and TB4 (2nd set) parameters. The switching between 1st and 2nd set occurs enabling terminal XM1-19 if param. DN3 = C_Par; otherwise the 1st set is always enabled.
			Ean1	From Ean1 input for both upper and lower limits. The Ean1 sign is irrelevant (the absolute value is used).
			Ean1C3	If terminal XM1-19 is disabled: Upper limit: fixed by TA3 parameter; Lower limit: fixed by TA4 parameter;
				If terminal XM1-19 is enabled:: From Ean1 input for both FWD and REV limits. The Ean1 sign is irrelevant (the absolute value is used).
			AuxRic	From aux. function (see description of the relevant function).
			Ean1/2	From Ean1 input for the upper limit; From Ean2 input for the lower limit.
			Ean1TL	From Ean1 input for the upper limit. From TA4 parameter for the lower limit.
			Ean2BL	From TA3 parameter for the upper limit. From Ean2 input for the lower limit.
CA3 260B	IaoAd	Off		Selection of an additional term origin, term to be added to the armature current reference:
			Off	Disabled selection.
			Ean1	From Ean1 analog input (with sign).
			Ean2	From Ean2 analog input (with sign).
			Ean2C3	If terminal XM1-19 is disabled: the additional term is not added.
				If terminal XM1-19 is enabled: from Ean2 analog input, with sign.
			IaoOfs	From TA5 param. (1st set) or from TB5 param. (2nd set); the switching between 1st and 2nd set occurs enabling terminal XM1-19 if param. DN3 = C_Par; otherwise the 1st set is always enabled.
			AuxAdd	From aux. function (see description of the relevant function).
CA4 261B	IaoWo	0	0-255 rad/s	Cutoff frequency of the filter on the current reference from the speed regulator. To disable the filter: CA4 = 0.
CA5 262W	RateL	100%	0-100%	Rate limit on the armature current reference value. The parameter shows the max. permitted variation of the current reference for each time interval T/6, where T is the network voltage period. Example: if T=20 ms and CA5 = 10% (referred to DB3), the max. permitted variation of the current reference is 10% every 3.3 ms.

Code	Name	Default	Values	Description
CA6 264W	IaLNM	100%	0.1-100%	Linear re-calibration of the armature current limits against the motor speed change in the range from the speed indicated by parameter DB7 to its max value, as shown in following figure:  to disable the re-calibration: CA6 = 100%.
CA7 266B	NMDel	0	0-244	Number of max delay to be executed during the armature current reversing procedure, after the zero current signal; normally CA7 = 0. If Silcopac D is used as exciter, then CA7 = 20 (avg recommended value).
CA8 268W	InThr	2%	0-50%	Intervention threshold value of the armature current reversing procedure. If the current reference, on sign change, drops below this threshold, the reversing procedure will be enabled. Otherwise the current reference will be zeroed without the reversing procedure.
CA9 270W	IaLim	100%	0-100%	Fixed current limits: Upper limit: positive limit fixed by the (+) CA9 parameter. Lower limit: negative limit fixed by the (-) CA9 parameter.
				Group B - SPEED REG.
CBA 288.0	Enable	ON	ON/OFF	Speed regulator enabled.
CBB 288.1	Enc_F	OF	ON/OFF	Filter enable on sign of the speed feedback from encoder. The filter rejects a sign reversing if the reversal isn't permanent during at least 3 consecutive readings. The filter isn't enabled if the system is in zero speed conditions, displayed by a 0 on the 7 segment LED.
CBC 288.2	Int=0	OFF	ON/OFF	Zeroing of the integral term when the speed reference = 0. Enable this function to avoid the "turn back" at the motor stop and braking, setting the speed reference = 0. Don't enable this function in lifting applications.
CBD 288.3	Rmp_B	ON	ON/OFF	It acts on the ramp function (see Appendix D –f 3): OFF : if terminal XM1-14 is enabled, the standard ramp function is enabled; : if terminal XM1-14 is disabled, the speed reference is zeroed. ON : if terminal XM1-14 is enabled, the standard ramp function is enabled; : if terminal XM1-14 is disabled, the emergency ramp function is enabled.
CBE 288.4	MpoMem	OFF	ON/OFF	EEPROM storage of the last reference set by motopotentiometer.
CBF 288.5	MpoRes	OFF	ON/OFF	Reset of the last reference set by motopotentiometer, when speed is equal to 0.
CBG 288.6	TacFUd	OFF	ON/OFF	Switching from speed feedback to armature voltage feedback when the tacho loss protection occurs. The converter is not locked, but the tacho loss alarm is enabled; in this case the alarm cannot be silenced. The following updating automatically will occur: -the proportional and integral gain of the speed loop are replaced by the gains fixed respectively by the TH7 and TH8 parameters; -the CB3 parameter, selection of the speed feedback origin, takes the value F(Ud); -the DDA alarm goes ON; -the flux reference takes the value 100%; - the speed reference is limited according to the following ratio: Speed limit =DB7
CBH 288.7	Wo_Ref	OFF	ON/OFF	Enable the angular speed evaluation as function of the measured diameter. The evaluated term is substituted to the line speed reference, acquired ad programmed by CB1 parameter, before of the summing term.

Code	Name	Default	Values	Description
CB1 289B	No_Sel	MPotFw		Selection of the speed reference origin:
			MPotFw	The reference is given by software motopotentiometer in the range 0 to 100%; CB9 parameter stores last set reference value; CB4 parameter stores the ramp time. COM1 input (terminal XM1-17) = increase; COM2 input (terminal XM1-18) = decrease;
			MPotC3	The reference is given by software motopotentiometer in the range from 0 to +100 % if COM3 input, terminal XM1-19, is not enabled; from 0 to -100 % if COM3 input, terminal XM1-19, is enabled. A COM3 change from 0 to 1 or from 1 to 0 becomes active only when the speed is zero. COM1 input (terminal XM1-17) = increase the absolute value. COM2 input (terminal XM1-18) = decrease the absolute value. CM9 parameter stores last set reference value; CB4 parameter stores the ramp time.
			Rif	The reference is acquired by the Rif analog input, with sign, terminals XM1-33, 34.
			Serial	From the serial link.
			AuxReg	Reserved.
			Rif_C3	From the differential analog Rif input (terminals XM1-33, 34). The speed reference sign depends on the status, acquired in zero speed conditions, of the logic input COM3 as in the following table: COM3 | Reference 0 | +|Rif| 1 | -|Rif|
			RifC12	From the differential analog Rif input (terminals XM1-33, 34). The sign of the speed reference depends on the status of the logic inputs COM1 and COM2, as in the following table: COM1 | COM1 | Reference 0 | 0 | 0 0 | 1 | |Rif| 1 | 0 | +|Rif| 1 | 1 | 0
			MPoRif	*Reference exchange by logic input COM4* *COM4 =OFF: from motopotentiometer* *COM4 =ON: from analog input Rif*
			SerRif	*Reference exchange by logic input COM4* *COM4 =OFF: from serial link* *COM4 =ON: from analog input Rif*
CB2 290B	NoAdd	Off		Selection of an additional term origin, term to be added to the speed reference:
			Off	Disabled selection.
			Ean2	From Ean2 analog input (with sign).
			Ean2C3	If terminal XM1-19 is disabled: the additional term is not added. If terminal XM1-19 is enabled: from Ean2 analog input, with sign.
			No_Ofs	Form TC6 param. (1st set) or from TD6 param. (2nd set); the switching between 1st and 2nd set occurs enabling terminal XM1-19 if param. DN3 = C_Par; otherwise the 1st set is always enabled.
			IntRef	From TC7 param. (1st set) or from TD6 param. (2nd set) enabling the INTRF1 input (terminal XM1-15). From TC8 param. (1st set) or from TD8 param. (2nd set) enabling the INTRF2 input (terminal XM1-16). The switching between 1st and 2nd set occurs enabling terminal XM1-19 if param. DN3C_Par; otherwise the 1st set is always enabled.
			AuxAdd	From aux. function (see description of the relevant function).
CB3 291B	N_Sel	Encod		Selection of the speed feedback origin:
			Encod	From encoder; set the following parameters: DB8 param.: pulses per revolution of the encoder. DB5 param.: max motor speed (rpm).
			Tach	From tacho generator.
			F(Ud)	From armature voltage; set the DB9 param.
			Serial	From serial link (hidden param.).
CB4 292W	MTime	10.0s	0.1-999.9s	Motopotentiometer ramp time.
CB5 294W	Nstop	2%	0-10%	Zero speed threshold; the threshold hysteresis can be set by CB6 param.
CB6 296W	NHist	0.3%	0-10%	Zero speed threshold hysteresis (see CB5 param.). Hysteresis for speed greater than threshold CE6 signalling (N>CE6) Hysteresis for reached speed signalling (ErrN=0 CB7) The hysteresis range, as absolute value, is defined by the following limits: upper limit: LSup = NStop + NHist lower limit: LInf = NStop - NHist (≥ 0.1%)

Code	Name	Default	Values	Description
CB7 298W	ErNLm	1%	0-10%	Tolerance for the reached speed signalling. The signalling occurs when the difference between the speed reference (before ramp) and speed feedback is lower than the parameter value.
CB8 300W	Enc_R	100%	0-200%	Recalibration of the speed feedback from encoder. Feedback sent to the speed regulator = feedback from encoder multiplied by CB8 / 100.
CB9 302W	M_Ref	0	0-200%	Last reference set by software motopotentiometer.
				Group C - E.M.F. REG.
CCA 322.0	Enable	ON	ON/OFF	Enable of the motor e.m.f. regulator (see function description).
CCB 322.1	Fld_In	OFF	ON/OFF	Enable of the motor field reversing aux. function (see function description). Before enabling this function, check that DA2=Unid and DM2=Ifo.
CCC 322.2	Fld0_P	ON	ON/OFF	Field current reference zeroing when the converter is in the Protection Status.
CCD 322.3	*FldSyn*	*OFF*	*ON/OFF*	*Enable of* the motor field reversing synchronisation function.
CC1 324W	FEcon	100%	0-100%	Filed saving, in other words decrease of the motor excitation current in respect to the If_{0MAX} value: $If = \frac{If_{0max} \cdot CC1}{100}$ The decrease occurs when the status is not "Regulation" and after a delay which can be set through parameter CC3 starting from zero speed signalling (see param. CB5). To disable: CC1 = 100%.
CC2 326W	FIDel	10	0-250	Delay time of the enable at the end of the field reversing, expressed in software cycles (see parameter CD3). The time can be calculated using the following formula: $T = CC2 \cdot CD3$
CC3 328W	FecTm	1000	1-9999	Delay time of the field save function, expressed in software cycles (see parameter CD3). The time can be calculated using the following formula: $T = CC3 \cdot CD3$
CC4 330W	*IfThr*	*100%*	*0-100%*	*Field current threshold for signalling on the logic output. See param.DO1-DO6*
				(i) Group D - MISCELLANEA
CDA 346.0	W_Eepr	ON	ON/OFF	Non-volatile EEPROM write enable of the parameters. If CDA = OFF the write occurs to volatile RAM memory; this storage will be valid until a Reset is performed or the supply is removed.
CDB 346.1	QuickS	OFF	ON/OFF	Quick motor restart enable function.
CDC 346.2	Diesel	OFF	ON/OFF	Enable this parameter when the converter is powered by a motor generator unit. This parameter allows the control software to bear wider variations of the converter power supply voltage periods.
CDE 346.4	IR12Ds	OFF	ON/OFF	Disable of the function substitution of the Start command by IntRf1 or IntRf2 command. OFF: IntRf1 and IntRf2 command (terminals XM1-15 and 16) substitutes the Start command enabling the converter. ON: IntRf1 and IntRf2 (terminals XM1-16 and 16) doesn't substitutes the Start command and when they are activate the converter isn't enabled.
CDF 346.5	Defaul	OFF	ON/OFF	Parameters programming with default values. To enable the parameters re-programming function with default values, close jumper JP19, program the CDF param. with the value ON and reset the drive. The converter goes in T - 5 status, the 7 segm. led on board shows the Test status; when the 7 segm. led on board is turned off and the 7 segm. led on SPDI1/SPDI2 terminal begins to light, reset another time the drive; the converter goes in T - 4 status; program the DA1 parameter with the drive serial number (see the drive label) and reset another time; the drive is now ready for a new programming.
CDG 346.6	EE_Sw	OFF	ON/OFF	Enabling of the Double set complete of parameters switching function See paragraph D1.17 for the function description.

Code	Name	Default	Values	Description
CD1 347B	RunEn	Run_1		Selection of the function allocated to the START input, terminal XM1-13:
			Run_1 *(SPDM..R)*	Start input = Run: Enabling the input the motor will start: the command gives the set speed reference and enables the pulses to the converter and the digital regulation Disabling the input the motor will stop with line recovery braking: the speed reference falls to zero (with ramp if installed); when the zero speed will be reached, the firing pulse will be forced to the max delay; the armature current falls to zero; the pulses will be suppressed; the suppression status will be stored; If the motor is dragged, the digital control doesn't react to the movement.
			Run_2 *(SPDM..R)*	Start input = Run. Enabling the input the motor will start: the command gives the set speed reference and enables the pulses to the converter and the digital regulation Disabling the input the motor will stop with line recovery braking: the speed reference falls to zero (with ramp if installed); when the zero speed will be reached, the firing pulse will be forced to the max delay; the armature current falls to zero; the pulses will be suppressed but the suppression status will not be stored. If the motor is dragged, the digital control reacts to the movement.
			Enable *(SPDM..U)*	Start input = enable. Enabling the input the motor will start: the command gives the set speed reference and enables the pulses to the converter and the digital regulation Disabling the input the motor will stop y inertia: the pulses will be suppressed, the armature current falls to zero; the suppression status will be stored. If the motor is dragged, the digital control doesn't react to the movement.
CD2 348B	Rel/%	%		Selection of the display mode of the variables, magnitude plus sign:
			%	As percent of the full scale value.
			Real	As real value.
CD3 349B	Cyc_T	10 ms	10 ms 5 ms 3.3 ms	Cycle time; it is the time period between two successive execution of the speed regulation algorithm.
CD4 350B	AbDel	15	1-255	Delay between Start input enabling (terminal XM1-13) and thyristor firing pulses actual enabling (see CD1 param.). This delay depends on the network voltage period. It is expressed as follows: $\text{Ritardo} = CD4 \cdot \frac{T}{6}$ — T=20 ms with network frequency equal to 50 Hz; T=16.7 ms with network frequency equal to 60 Hz.
CD5 351B	Nz_D	10	0-250	Delay on K1 relay open when zero speed is reached, expressed in software cycles (see par. CD3).
CD6 352W	N_MxV	100%	0.1-100%	Maximum speed feedback variation allowed per software cycle (see par. CD3).
CD7 354B	N_Flt	0 rad/s	0-255 rad/s	Single pending filter on speed feedback.
CD8 355B	IlThr	5%	0.1-10%	Threshold for the drive in current limit signalling. When the difference, in absolute value, between the limit current value and the reference current value is smaller than the value set to this param. the drive in current limit signalling becomes ON and the speed regulator integral value is frozen.
Gruppo E - AUX. FUNCT. 1				
CEA 372.0	Helper	OFF	ON/OFF	Helper aux. function enable. See function description.
CEB 372.1	Pope	OFF	ON/OFF	Pope aux. function enable. See function description.
CEC 372.2	Dis Reg	OFF	ON/OFF	Regenerative braking disabling if armature voltage is greater than the threshold fixed with CE2 parameter
CED 372.3	MLoss	OFF	ON/OFF	Mechanical loss compensation aux. function. See function description.
CE1 374W	NoRic	10%	0-20%	Additional term to be added to the speed reference (offset speed). See Pope and Helper aux. functions.
CE2 376W	U_Thr	10%	0-100%	Armature voltage threshold for regenerative braking disabling.
CE3 378W	LossK	10%	0-100%	Compensation term of the constant mechanical losses (i.e. not dependent on the speed). See Mechanical Losses Compensation aux. function).
CE4 380W	LK_N	10%	0-100%	Compensation term of the mechanical losses which linearly depends on the speed. See Mechanical Losses Compensation aux. function.
CE5 382W	IaThr	10%	0-100 %	Current threshold for the signalling on logic output. See parameters from DO1 to DO6.
CE6 384W	N_Thr	10%	0-100 %	Speed threshold for the signalling on logic output. See parameters from DO1 to DO6.

Code	Name	Default	Values	Description
			Group F - AUX. FUNCT. 2	
CFA 400.0	NoAdVR	OFF	ON/OFF	ON = the additional term to the speed reference is added downstream the ramp. OFF = the additional term to the speed reference is added upstream the ramp.
CFB 400.1	T_Prf	OFF	ON/OFF	Torque-proof aux. function enable. See function description.
CFC 400.2	L_W	OFF	ON/OFF	Load Weighting aux. function enable. See function description.
CFD 400.3	SWCom4	OFF	ON/OFF	Commands exchange (Start, Ramp,IntRef1, IntRef2, COM1, COM2, COM3) from serial link to terminal board by logic input COM4 (SPDI/O option). The function is enabled if CB1 is programmed as SerRif only: COM4 = OFF: commands from serial link (if DEB = ON) COM4 = ON: commands from terminal board
CFE 400.4	Flux_R	OFF	ON/OFF	Recalibration of the speed regulator gain as function of the motor flux.
CFF 400.5	FUd_C3	OFF	ON/OFF	Selection of the base speed value and of the speed feedback origin depending on logic input COM3 status (terminal XM1-19). If par. CFF = ON and COM3 is neither active nor programmed on C_Par (see par. DN3), speed feedback origin is defined by parameter CB3, whereas base speed is defined by par. DB7. If par. CFF = ON, COM3 is both active and programmed on C_PAR (see par. DN3), speed feedback origin is drawn from aramature current, base speed is set to 100% and the flux takes the value set by parameter CC4.
CF1 402W	TPLim	10%	0-100%	Reduction factor of the current limit during the brake opening transient. See Torque-proof aux. function description.
CF2 404B	TP_T	100	0-255	Time period, expressed in software cycles (see par. CD3), during which the CF1 parameter is acting. See Torque-proof aux. function description.
CF3 406W	LW_Fr	10%	0-100 %	Compensation parameter for the lowering friction torque. See Load Weighting aux. function description.
CF4 408W	LW_Tm	50	1-127	Weighting time for the load weight function, expressed in software cycles (see par. CD3), according to the formula: $T = 2 \cdot CF6 \cdot CD3$.
CF5 410B	ErNAR	10%	0-20%	Speed error threshold (after ramp) for Logic-Output signal.
CF6 411B	ErN_T	10	0-250	Time after which if the speed error (after ramp) is greater than CF7 par. a Logic-Output is active. It is expressed in software cycles (see par. CD3).

B1.2 Tuning parameters

Code	Name	Default	Values	Description
				Group A - CURRENT REG.
Note	The parameters group A (1st set) is an alternate set of the parameters group B (2nd set); the switching from 1st to 2nd set occurs enabling the terminal XM1-19 if parameter DN3 = C_Par; otherwise the 1st set will always enabled.			
TA1 002W	G_P1	32	0÷9999	First proportional gain of the current regulator.
TA2 004B	G_d1	56	0÷255	First derivative gain of the current regulator.
TA3 006W	IaTL1	100%	±100%	First upper current limit, as % of Ia_M.
TA4 008W	IaBL1	-100%	±100%	First lower current limit, as % of Ia_M
TA5 010W	IaOf1	0	± 100%	Additional term, to be added to the armature current reference; it is selected by the CA3 parameter. It is also used by several aux. functions.
TA6 012B	DeadT	0	0÷10	Dead zone in the bridges changing. The value assigned to TA6 is a delay calculated according the fomula: Dead zone time= TA6 * T / 6. with T = power supply period. We suggest to set TA6 =0.
				Group B - ALT. CURRENT
Note	The parameters group B (2nd set) is an alternate set of the parameters group A (1st set); the switching from 1st to 2nd set occurs enabling the terminal XM1-19 if parameter DN3 = C_Par; otherwise the 1st set will be always enabled.			
TB1 026W	G_P1	32	0÷9999	Second proportional gain of the current regulator.
TB2 028B	G_d1	56	0÷255	Second derivative gain of the current regulator.
TB3 030W	IaTL1	100%	±100%	Second upper current limit, as % of Ia_M
TB4 032W	IaBL1	-100%	±100%	Second lower current limit, as % of Ia_M
TB5 034W	IaOf1	0	± 100%	Additional term, to be added to the armature current reference; it is selected by the CA3 parameter. It is also used by several aux. functions.
				Gruppo C - SPEED REG.
Note	The parameters group C (1st set) is an alternate set of the parameters group D (2nd set); the switching from 1st to 2nd set occurs enabling the terminal XM1-19 if parameter DN3 = C_Par; otherwise the 1st set will always enabled.			
TC1 050W	N_Gp1	400	0÷9999	First proportional gain of the speed regulator.
TC2 052W	N_Gi1	80	0÷8000	First integral gain of the speed regulator.
TC3 054W	N_Gd1	0	0÷255	First lead-lag network (derivative section) of the speed regulator; it is implemented as a filter with zero and pole on the feedback. The characteristic frequencies of the filter have the following values: filter pole Wp = TC3 / 20 .48 rad/s filter zero Wz = TC3 / 102 .4 rad/s To disable the filter, set TC3 to 0.
TC4 056W	NoLA1	100%	0÷120%	First FWD speed limit.
TC5 058W	NoLI1	-100%	-120÷0%	First REV speed limit.
TC6 060W	NoOf1	0	±100%	Additional term, to be added to the speed reference. It is selected by the CB2 parameter.
TC7 062W	InR11	30%	±100%	First internal reference no. 1. Its value will be replaced to the speed reference when the INTRF1 input is enabled, terminal XM1-15.
TC8 064W	InR21	-30%	±100%	First internal reference no. 2. Its value will be replaced to the speed reference when the INTRF2 input is enabled, terminal XM1-16. If both inputs INTRF1 and INTRF2 are enabled, the priority will be given to INTRF1.
TC9 066W	Ced1	0	0÷10%	Drooping. This parameter causes a motor speed decrease as function of the sink current, arranging the speed error according to the following formula: Error_N= Ref_N - Feedback - (Ref_I * TC9) where: Error_N = speed error (%) Ref_N = speed reference (%) Feedback = speed feedback (%) Ref_I = present current reference (from speed regulator) (%)

Code	Name	Default	Values	Description
		(ii)		Group D - ALT. SPEED
Note	The parameters group D (2nd set) is an alternate set of the parameters group C (1st set); the switching from 1st to 2nd set occurs enabling the terminal XM1-19 if parameter DN3 = C_Par; otherwise the 1st set will be always enabled.			
TD1 082W	N_Gp2	400	0÷9999	Second proportional gain of the speed regulator.
TD2 084W	N_Gi2	80	0÷8000	Second integral gain of the speed regulator.
TD3 086W	N_Gd2	0	0÷255	Second lead-lag network (derivative section) of the speed regulator; it is implemented as a filter with zero and pole delay) on the feedback. The characteristic frequencies of the filter have the following values: filter pole Wp = TD3 / 20 .48 rad/s filter zero Wz = TD3 / 102 .4 rad/s To disable the filter, set TD3 to 0.
TD4 088W	NoLA2	100%	0÷120%	Second FWD speed limit.
TD5 090W	NoLI2	-100%	-120÷0%	Second REV speed limit.
TD6 092W	NoOf2	0	±100%	Additional term, to be added to the speed reference. It is selected by the CB2 parameter.
TD7 094W	InR12	30%	±100%	Second internal reference no. 1. Its value will be replaced to the speed reference when the INTRF1 input is enabled, terminal XM1-15.
TD8 096W	InR22	-30%	±100%	Second internal reference no. 2. Its value will be replaced to the speed reference when the INTRF2 input is enabled, terminal XM1-16. If both inputs INTRF1 and INTRF2 are enabled, the priority will be given to INTRF1.
TD9 098W	Ced2	0	0-10%	Drooping. This parameter causes a motor speed decrease as function of the sink current, arranging the speed error according to the following formula: Error_N= Ref_N - Feedback - (Ref_I * TD9) Error_N = speed error (%) Ref_N = speed reference (%) Feedback = speed feedback (%) Ref_I = present current reference (from speed regulator) (%)
				Group E - RAMP
Note	The parameters group E (1st set) is an alternate set of the parameters group F (2nd set); the switching from 1st to 2nd set occurs enabling the terminal XM1-19 if parameter DN3 = C_Par; otherwise the 1st set will always enabled.			
TE1 114W	TacR1	10s	0.1-999.9s	First time of the acceleration ramp; it is the time period needed by the motor to increase its speed from 0 to 100%.
TE2 116W	TdcR1	10s	0.1-999.9s	First time of the deceleration ramp; it is the time period needed by the motor to decrease its speed from 100% to 0.
TE3 118B	TarRm	0	0-7.5s	Ramp rounding time.
		(iii)		Group F - ALT. RAMP
Note	The parameters group F (2nd set) is an alternate set of the parameters group E (1st set); the switching from 1st to 2nd set occurs enabling the terminal XM1-19 if parameter DN3 = C_Par; otherwise the 1st set will always enabled.			
TF1 134W	TacR2	10s	0.1-999.9s	Second time of the acceleration ramp; it is the time period needed by the motor to increase its speed from 0 to 100%.
TF2 136W	TdcR2	10s	0.1-999.9s	Second time of the deceleration ramp; it is the time period needed by the motor to decrease its speed from 100% to 0.
				Group G - E.M.F. REG.
Note	This group includes the parameters of the E.M.F. Regulator aux. function (see).			
TG1 154W	E_Gp	100	0-9999	Proportional gain of the motor e.m.f. regulator.
TG2 156W	E_Gi	16	0-8000	Integral gain of the motor e.m.f. regulator.
				Group H - GAINS ADAPT.
TH1 220W	TcFGp	0	0-9999	Proportional gain of the speed loop with speed feedback coming from the armature voltage. See CBG parameter.
TH2 222W	TcFGi	0	0-8000	Integral gain of the speed loop with speed feedback coming from the armature voltage. See CBG parameter.
TH3 224W	TacRF	0	0-999,9	Time of the emergency acceleration ramp: it is the time period needed by the motor to increase its speed from 0 to 100%.
TH4 226W	TdcRF	0	0-999,9	Time of the emergency deceleration ramp: it is the time period needed by the motor to decrease its speed from 100% to 0.

B1.3 Drive parameters

Code	Name	Default	Values	Description
				Group A - DRIVE IDENTIF.
DA1 514W	SNumb	0	0-9999	Silcopac D serial number. The zero default value doesn't allow the system to start at Power Up. The display shows: STATUS TEST ENTER PAR. DA1 This request tells to the user that all parameters stored in the EEPROM memory have their default value. This situation occurs when the EEPROM on the board isn't still programmed; e.g. when a fault EEPROM is replaced with another blank one. If needed, the user at this point can set the proper values; at the end, enter the chosen serial number and press RESET button.
DA2 516B	Bridg	Unid		Converter type selection.
			Unid.	2 quadrant (Unidirectional) converter.
			Rev.	4 quadrant (Reversible) converter.
Note	For proper operation of the fuses intervention protection it is mandatory the proper selection of this parameter.			
DA3 517B	Thyr	30		Converter size selection.
			30	Rated converter current = 30 A
			60	Rated converter current = 60 A
			80	Rated converter current = 80 A
			110	Rated converter current = 110 A
			160	Rated converter current = 160 A
			200	Rated converter current = 200 A
			260	Rated converter current = 260 A
			350	Rated converter current = 350 A
			450	Rated converter current = 450 A
			500	Rated converter current = 500 A
			600	Rated converter current = 600 A
			750	Rated converter current = 750 A
			850	Rated converter current . 850
			1K1	Rated converter current = 1100 A This selection is correct for new size 1M1 too
			1M0	Rated converter current = 1000 A
			1K2	Rated converter current = 1100 A
			1K5	Rated converter current = 1500 A
			1K6	Rated converter current = 1650 A
			1K7	Rated converter current = 1700 A
			2K1	Rated converter current = 2100 A
			2K2	Rated converter current = 2200 A
			2K5	Rated converter current = 2500 A
			3K1	Rated converter current = 3100 A
			3K6	Rated converter current = 3600 A
			4K0	Rated converter current = 4000 A
				Note: For proper operation of the converter thermal protection it is mandatory that the DA3 parameter is configured according the real SPDM size, indipendently of the current that the converter will supply in operation. It is also necessary to select the armature current full scale par. DB3.
				Group B - DRIVE I / O
DB1 524W	UvoFs	380 V	0-9999V	Line voltage full scale selection (rms value of the converter supply voltage).
DB2 526W	If_Fs	3 A	0-999.9 A	Motor field current full scale value.
DB3 528W	Ia_Fs	30 A	0-9999 A	Converter current full scale value. The value of this parameter must correspond to the Ia_M value as shown in par. 3.3 C section of this manual (CT load resistors).
DB4 530W	Ud_Fs	400 V	0-9999 V	Armature voltage full scale value.
DB5 532W	N_Fs	2000	0-9999 giri/min	Motor angular speed full scale value.
DB6 534W	IaNom	100%	0-100%	Motor nominal current as % of Ia_M.
DB7 536W	NBase	100%	0-100%	Motor basic speed as % of the max speed. It is the speed beyond which the e.m.f. regulator reduces the motor field current.
DB8 538W	Enc_P	500 V	0-9999	Pulse/rev ratio of the used encoder.
DB9 540W	RI%	0	0-100%	RI drop across the motor as % of the DB4 parameter. It is the armature voltage when the rotor is locked, at armature current = 100%, so equal to Ia_M .

Code	Name	Default	Values	Description
				(iv) Group C - PROTECTIONS
Note				This group includes the parameters used to enable the Protections intervention. See also the next group D - ALARMS, that includes the enabling parameters of the alarms intervention; the parameters of groups C and D are related each one to other because each intervention can be defined as follows: Protection: if the intervention is reported and the converter is stopped (DCx parameter of group DC-PROTECTIONS); Alarm: if the intervention is reported without the stop of the converter (DDy parameter of group DD-ALARMS); x, y identify the active protection or alarm (i.e. DCA = line loss). 1º DCx=*OFF* DDy=*OFF* intervento disattivato 2º DCx=*OFF* DDy=*ON* intervento attivato come allarme 3º DCx=*ON* DDy=*ON* intervento attivato come protezione 4º DCx=*ONF* DDy=*ON* intervento attivato sia come protez. sia come allarme
Warning:				only status 3 is allowable for interventions (0), (1), (2), (3), (10). Status 2 and status 4 are not allowable for interventions (4), (5), (11), (12), (14).
DCA 550.0	MainF	ON	ON/OFF	(0) Line loss. The system forces the converter to the maximum delay, followed by pulses suppression. This hardware protection cannot disabled.
DCB 550.1	Ext_P	ON	ON/OFF	(1) External protection. An external protection is active opening the terminal XM1-20, disabling the converter; the relay K2 (converter ready) is not de-energized. The intervention is not internally stored, so the converter will be enabled again if the protection loss causes the closing of terminal XM1-20. This hardware protection cannot be disabled.
DCC 550.2	IOC	ON	ON/OFF	(2) Max instantaneous current. The intervention of this protection occurs when the voltage drop on the CT load resistor rises beyond 6.3 V; see par. 3.3 of manual C Section. This hardware protection cannot be disabled.
DCD 550.3	W_Dog	ON	ON/OFF	(3) Watchdog.
DCE 550.4	Ud_F	ON	ON/OFF	(4) Max armature voltage. The intervention threshold can be set through the DC5 parameter. The intervention may be also caused by the voltage transducer failure; in this case the protection will be active if the motor speed rises beyond the basic speed (DB7 parameter), while the transducer reports a voltage value lower than 50% of the rated value.
DCF 550.5	If_F	ON	ON/OFF	(5) Motor field loss. The intervention may be also caused by the exciter failure. The minimum intervention threshold can be adjusted by the DC3 parameter.
DCG 550.6	Tach_F	ON	ON/OFF	(6) Tacho signal loss. The protection is active when the armature voltage rises beyond the threshold value set by the parameter DD2, at null speed feedback. (tacho generator or encoder broken) This protection is also active when the tacho voltage is applied with reversed polarity. See also par. DDA.
DCH 550.7	Fan_F	ON	ON/OFF	(7) Ventilation loss. Converter heat sink thermostat intervention. See also par. DDB.
DCI 551.0	MotOh	ON	ON/OFF	(8) Motor over temperature. For proper operation of this protection, the DB6 parameter must be programmed as follow: DB6 = 100 * Ia_N / Ia_M Ia_N = rated armature current Ia_M = max armature current See DC8 and DDC parameters too.
DCJ 551.1	ConOh	ON	ON/OFF	(9) Converter over temperature. For proper operation of this protection, the following parameters must be programmed: DA3 = Converter size DB3 = Ia_M See DDD parameter too.
DCK 551.2	Ser_F	ON	ON/OFF	(10) Serial link loss. The intervention occurs if the serial communication is broken. The protection is active only if the serial link is enabled. See note %% par. C2.1
WARNING !				If the converter receives current or speed references from the serial line, serial link loss disabling must be carried out with utmost care. In this condition, when serial link loss occurs, the converter uses the last received reference: the user can therefore select the next action, using the signal coming from either digital outputs configured as 'Alarm' (see the description of parameters DDE, DEF and DO1...DO6.
DCL 551.3	N_Max	ON	ON/OFF	(11) Motor max speed. The intervention threshold can be adjusted by DC4 parameter.
DCM 551.4	UvOut	ON	ON/OFF	(12) Supply line beyond tolerance. The minimum intervention threshold can be adjusted by DC1; the maximum one can be adjusted by DC2.
DCN 551.5	Stale	ON	ON/OFF	(13) Motor in stall conditions. The intervention occurs if the stall time, with the motor in current limit conditions, rises beyond the value set by DC6. This protection is not active if the current limit is lower than 25%. of Ia_N. The Ia_N value is set by DB6. See DDF parameter too.

Code	Name	Default	Values	Description
DCO 551.6	Leg_F	ON	ON/OFF	(14) Leg failure. This protection is enabled when at least two phases (fuse failure or open contactors) are missing during regulation. In more details, the protection intervention occurs if at a certain time the following condition is true: armature current Ia = 0; armature voltage Va = 0; phase shift angle α < 80°. For proper operation, the DA2 parameter must be programmed.
DC1 552W	UvoMn	80%	60-100%	Intervention threshold of the line under voltage protection, as % of the rated line value.
DC2 554W	UvoMx	115%	100-120%	Intervention threshold of the line over voltage protection, as % of the nominal line value.
DC3 556W	Fld_L	10%	1-50%	Intervention threshold of the min. excitation protection.
DC4 558W	N_Max	115%	0-124%	Intervention threshold of the max motor speed protection.
DC5 560W	UdMax	120%	100-124%	Intervention threshold of the max armature voltage protection.
DC6 562B	TStal	5 s	0-25 s	Time period after which the stall protection occurs, if the motor is in steady and current limit conditions.
DC7 564W	MOH_R	100%	0-150%	Recalibration of the motor thermal protection intervention threshold. See DCI parameter too.
DC8 566W	Fld_T	20%	1-50%	Tolerance on the field current feedback signal. If the difference between the reference and the field current feedback is, in absolute value, greater than DC9 parameter during more than 2.5s the system goes in If_F protection status.
		(v)		Group D - ALARMS
Note	This group includes the enabling parameters of the alarms intervention. See the note at the previous Group C-PROTECTIONS, because the parameters of groups C and D are related each one to other.			
DDA 572.6	Tach_F	OFF	ON/OFF	Tacho signal loss. See DCG parameter too.
DDB 572.7	Fan_F	OFF	ON/OFF	Ventilation loss. See DCH parameter too.
DDC 573.0	MotOh	OFF	ON/OFF	Motor thermal protection. See DCI parameter too.
DDD 573.1	ConOh	OFF	ON/OFF	Converter thermal protection. See DCJ parameter too.
DDE 573.2	Ser_F	OFF	ON/OFF	Serial link loss. See DCK parameter too.
DDF 573.5	Stale	OFF	ON/OFF	Motor in stall conditions. See DCN parameter too.
DD1 574B	ResAl	0	0 – 1	Active alarms silence (no disable!). Setting this parameter to 1, all the active alarms will be silenced at the same time; immediately after, the parameter automatically will be set back to 0. The DD1 parameter set-up is possible by the serial link too.
DD2 576W	TachAl	50%	0-00%	Armature voltage threshold above that the "Tacho signal loss". protection is enabled
Note	By the PROTES & ALARMS function it's possible to silence each active alarm one at a time, through the SPDI1/ SPDI2) keypad.			
	(vi)			Group E - SERIAL LINK
Note	*(a)*	*This group includes the parameters of the serial link function.*		***See the documentation about this subject.***
DEA 582.0	Profib	OFF	ON/OFF	Profibus serial link enable.
DEB 582.1	S_Com	OFF	ON/OFF	Logic command enable via the serial link; these command are AND with the relevant physical commands (terminal XM1-13, 14, 15, 16, 17, 18, 19).
DEC 582.2	S_ComD	OFF	ON/OFF	Logic command disable via the serial link: if DEF = ON the control, with serial link loss, disables automatically the parameter DEB, keeping active the commands from terminals XM1-13, 14, 15, 16, 17, 18, 19. So it is possible to use the emergency commands. The disabling of the parameter DEB is stored in EEPROM.
DED 582.3	PC_Com	OFF	ON/OFF	ON = PC_Tool enabling
DEE 582.4	ResPRF	OFF	ON/OFF	ON = board reset via Profibus. See Appendix F2.5
DE1 583B	Ptcol	PPO3	PPO1 PPO2 PPO3 PPO4 PPO5	Profibus Protocol
DE2 584B	StAdd	3	3-32	Converter identification number.

Code	Name	Default	Values	Description
				(vii) Group E - SERIAL DATA
Note:	This group includes the parameters to select from diagnostic DATABASE the data (no more than 10) to be transmitted via the serial link, as reply to a data request (referenced as D1 data). The diagnostic DATABASE includes 32 data bytes of the DRIVE TRACE.			
DFA 594.0	D1RnSt	OFF	ON/OFF	Reading number N. of the STATUS recordings
DFB 594.1	D1RPro	OFF	ON/OFF	Reading of the word PROTECTIONS
DFC 594.2	D1RAbi	OFF	ON/OFF	Reading of the word LOGIC I / O
DFD 594.3	D1RAu1	OFF 1	ON/OFF	Reading of the auxiliary variable Aux1
DFE 594.4	D1RAu2	OFF	ON/OFF	Reading of the auxiliary variable Aux2
DFF 594.5	D1RAu3	OFF	ON/OFF	Reading of the auxiliary variable Aux3
DFG 594.6	D1RNo	OFF	ON/OFF	Reading of speed reference No
DFH 594.7	D1R_N	OFF	ON/OFF	Reading of speed feedback N
DFI 595.0	D2RIao	OFF	ON/OFF	Reading of the armature current reference
DFJ 595.1	D2R_Ia	OFF	ON/OFF	Reading of the armature current feedback
DFK 595.2	D2R_Ud	OFF	ON/OFF	Reading of the armature voltage
DFL 595.3	D2RFlu	OFF	ON/OFF	Reading of motor flux
DFM 595.4	D2RIfo	OFF	ON/OFF	Reading of the field current reference
DFN 595.5	D2R_If	OFF	ON/OFF	Reading of the field current feedback
DFO 595.6	D2RUvo	OFF	ON/OFF	Reading of the power supply voltage
DFP 595.7	D2R_α	OFF	ON/OFF	Reading of the alfa command (electr. degree)
DFa 596.0	D1WEn1	OFF	ON/OFF	Over-writing via Profibus of the analog input Ean1
DFb 596.1	D1WEn2	OFF	ON/OFF	Over-writing via Profibus of the analog input Ean2
DFc 596.2	D1WAu1	OFF	ON/OFF	Writing via Profibus of the variable Profib (see DG5 parameter)
				(viii) Group G - DIAGNOSTICS
DGA 606.0	TStop	OFF	ON/OFF	Stop and Trace storage: ON at the status change Regulation to Suppression/Protection. OFF at the status change to Protection.
DGB 606.1	SStop	OFF	ON/OFF	Stop and Trace storage when the SETUP REFERENCE function is enabled: ON at the acquisition of the new reference value pressing ENTER button. OFF Stop disabled.
DGC 606.2	Inst_M	OFF	ON/OFF	Display following power up or reset: ON INSTRUMENT MODE window is displayed OFF STATUS window is displayed
DGD 606.3	*C2Stop*	*OFF*	*ON/OFF*	*Traces storing by logic command COM2* The traces are frozen at low→high of COM2 changing.
DGE 606.4	*Autopr*	*OFF*	*ON/OFF*	*Traces AUTOPRINT enabled by external protection intervention:* *OFF The 'auto print is not done:* *ON The auto print is done:*
DG1 607B	TrcNr	25	5-45	Number of record stored in the DRIVE TRACE after the lock instant.
DG2 608B	TrcNc	1	1-255	Software cycles number between two successive DRIVE TRACE records. The corresponding time interval is given by the following formula: $T = CD3 \cdot DG2$ (ms)

Code	Name	Default	Values	Description
DG3 609B	Th_Nr	7	2-14	THYRISTOR TRACE records number after the lock instant.
DG4 610B	StatV	N		Displayed variable in the STATUS = REGUL.
			Aux1	1st aux. variable
			Aux2	2nd aux. variable
			Aux3	3rd aux. variable
			No	speed reference (rpm)
			N	speed feedback (rpm)
			Iao	armature current reference
			Ia	armature current feedback
			Ud	armature voltage
			Flu	motor flux
			Ifo	field current reference
			If	field current feedback
			Uvo	supply line voltage
			alfa	thyristor firing angle (electrical degrees)
Selection of the meaning assigned to the Aux1 aux. variable. In example: selecting Ean1 as DG5 value then DG5 = Ean1 the following self assignment is generated: Aux1 = Ean1				
Note:	The following values and description are true for the two next DG6 and DG7 parameters too.			
DG5 611B	Aux1S	AuxDgn	Rif	Diff. reference input (Rif) terminals XM1-33, 34
			Tach	Tacho gen. input (Tach) terminals XM1-26, 27
			Ean1	Programmable input (Ean1) terminals XM1-29, 31
			Ean2	Programmable input (Ean2) terminals XM1-30, 31
			IaoNrg	Armature current reference generated by the speed regulator (upstream current limits).
			N_Err	Speed error before ramp.
			EMF	Evaluated motor e.m.f. (Ud - RI).
			Motop	Reference from the software motopotentiometer.
			Period	Supply line period, given in ms (i.e. 20.0% means 20.0 ms).
			Duty_C	Duty Cycle discontinuity rate of the armature current). 0.0 % = continuos current; 70.0 % = null current.
			Free_T	Free residual time of the μC, as % of the cycle time (see CD3 parameter). The free time expressed as ms is given by the following formula:.Aux1 · CD3 / 100000 (ms)
			AuxDgn	Four bits showing the ON or the OFF status of the logic outputs OUT3, OUT4, OUT5, OUT6.
			BR_Ref	Speed reference before the ramp.
			Power	Power sourced by the motor, given by Ud • Ia, as % of the nominal value Ud_N • Ia_N. Ud = armature voltage as % of the nominal voltage Ia = armature current as % of the Ia_M current.
			To Ref	Tension reference (see the Tension Adaptive Regulator aux. function).
			T_Comp	Tension regulator output (see the Tension Adaptive Regulator aux. function).
			Diam.	Roll diameter.
			Iao_To	Current reference to obtain the desired tension.
			Iner.	Current reference for the inertia compensation.
			M_Loss	Current reference for the mechanical loss compensation.
			N_Prop	Speed regulator proportional term.
			N_Int	Speed regulator integral term.
			N_Der	Speed regulator derivative term.
			dNo/dt	Speed reference change.
			Line_N	Acquired line speed.
			M_Temp	Motor to ambient temperature delta (%, 100% = max).
			C_Temp	Converter to ambient temperature delta (%, 100% = max).
			UnfPer	Unfiltered supply line period.
			Flt_N	Filtered speed feedback (see par. CD6).
			Torque	Torque, calculated as Flux • Armature current (as % of the max available motor torque).
			RotPos	Rotor position. See param. CGC.
			MecPow	Motor shaft power (in % of the rated power)
			Encod	It is displayed the speed measured by an encoder It is possible to connect an encoder to the proper terminal even if the speed feeback generator is a tacho-generator or the armature voltage.
			Profib	Variable sent by a Master Profibus.

Code	Name	Default	Values	Description
DG6 612B	Aux2S	Ean1	Vedi (1)	Selection of the meaning assigned to the Aux2 aux. variable. In example selecting Tach as DG6 value then DG6 = Tach the following self assignment is generated: Aux2 = Tach
DG7 613B	Aux3S	Ean2	Vedi (1)	Selection of the meaning assigned to the Aux3 aux. variable. In example: selecting N_Err as DG7 value the DG7 = N_Err the following self assignment is generated:Aux3 = N_Err.
DG8 614W	D_Ref	10 %	0 100 %	Amplitude of the square wave selected in SETUP REFERENCE.
DG9 616B	TimeP	1 s	0.1 10 s	Period of the square wave selected in SETUP REFERENCE.
6 analog inputs are available (Rif➔XM1-32/34, Ean1➔XM1-29, Ean2➔XM1-30, Tach➔XM1-26, If➔XM1-28,Varm➔ XM1-32). Ean1, Ean2, Tach, If are programmable				
Group H - ANALOG INP. OFS				
Note	This group includes the parameters for the analog inputs offset compensation, as % of the full scale value.			
DH1 626W	TacOf	0	±100%	Tacho gen. input (Tach) Terminals XM1-26, 27
DH2 628W	IfOfs	0	±100%	Field current input (If) Terminals XM1-28, 31
DH3 630W	E1Ofs	0	±100%	Programmable input (Ean1) Terminals XM1-29, 31
DH4 632W	E2Ofs	0	±100%	Programmable input (Ean2) Terminals XM1-30, 31
DH5 634W	UdOfs	0	±100%	Armature voltage input (Varm) Terminals XM1-32, 31
DH6 636W	RifOf	0	±100%	Ref. diff. input (Rif) Terminals XM1-33, 34
Group J - ANALOG INP. GN.				
Nota	This group includes the parameters for the analog inputs gain adjustment; the parameters for the transducers recalibration are included too (supply line voltage and armature current). Gain = 100% means gain = 1.			
DJ1 646W	TachG	100 %	97-249%	Tacho gen. input (Tach) terminals XM1-26, 27
DJ2 648W	If_G	100 %	± 249%	Field current input (If) terminals XM1-28, 31
DJ3 650W	Ean1G	100 %	± 249%	Programmable input (Ean1) terminals XM1-29, 31
DJ4 652W	Ean2G	100 %	± 249%	Programmable input (Ean2) terminals XM1-30, 31
DJ5 654W	Ud_G	100 %	97-249%	Armature voltage input (Varm) terminals XM1-32, 31
DJ6 656W	Rif_G	100 %	± 249%	Ref. diff. input (Rif) terminals XM1-33, 34
DJ7 658W	Uvo_G	100 %	0-249%	Supply line transducer recalibration.
DJ8 660W	Ia_G	100 %	0-150%	Armature current transducer recalibration (CT load resistors); see paragraph 3.3 section C.
Group K - ANALOG INP. FLT				
Note	On each analog input a dual slope digital filter can be included, the cutoff frequency of which can be set the related parameter. The filter is enabled assigning to the parameter a value greater than 2 and is disabled assigning to the parameter a value ≤ 2.			
DK1 670B	TacFl	0	0-255 rad/s	Tacho gen. input (Tach) terminals XM1-26, 27
DK2 671B	If_Fl	20	0-255 rad/s	Field current input (If) terminals XM1-28, 31
DK3 672B	Ean1F	0	0-255 rad/s	Programmable input (Ean1) terminals XM1-29, 31
DK4 673B	Ean2F	0	0-255 rad/s	Programmable input (Ean2) terminals XM1-30, 31
DK5 674B	Ud_Fl	0	0-255 rad/s	Armature voltage input (Varm) terminals XM1-32, 31
DK6 675B	RifFl	0	0-255 rad/s	Ref. diff. input (Rif) terminals XM1-33, 34

Code	Name	Default	Values	Description		
(ix)				Group L - ANALOG INP. ABS		
Note	Each analog input can be acquired by the system as absolute value or as magnitude plus sign. This group includes the parameters for the mode selection:					
DLA 684.0	TacAb	OFF	ON/OFF	Tacho gen. input	(Tach)	terminals XM1-26, 27
DLB 684.1	IfAbs	OFF	ON/OFF	Field current input	(If)	terminals XM1-28, 31
DLC 684.2	E1Abs	OFF	ON/OFF	Programmable input (Ean1)	terminals XM1-29, 31	
DLD 684.3	E2Abs	OFF	ON/OFF	Programmable input (Ean2)	terminals XM1-30, 31	
DLE 684.4	RifAbs	OFF	ON/OFF	Ref. diff. input	(Rif)	terminals XM1-33, 34
(x)				Group M - ANALOG OUTPUTS		
3 analog outputs are available (Ia➔XM1-35/36, PWM1➔XM1-37/38, PWM2➔XM1-39/41, PWM3➔XM1-40/41). PWM1, PWM2, PWM3 are programmable						
Nota	This group includes the three analog outputs relevant parameters. PWM1 PWM2 PWM3					
DMA 694.0	Pw1Ab	OFF	ON/OFF	PWM1 analog output	Parameters for the output mode selection:	
DMB 694.1	Pw2Ab	OFF	ON/OFF	PWM2 analog output	ON	as absolute value.
DMC 694.2	Pw3Ab	OFF	ON/OFF	PWM3 analog output	OFF	as magnitude plus sign.
DM1 695B	Pw1SI	Ud	vedere (2)	Uscita analogica PWM1	(2) Parameters for the output meaning selection:	
DM2 696B	Pw2SI	Ifo	vedere (2)	Uscita analogica PWM2	Aux1	1st aux. variable
DM3 697B	Pw3SI	N	vedere (2)	Uscita analogica PWM3	Aux2	2nd aux. variable
					Aux3	3rd aux. variable
					No	speed reference
					N	speed feedback
					Iao	armature current reference
					Ia	armature current feedback
					Ud	armature voltage
					Flu	motor flux
					Ifo	field current reference
					If	field current feedback
					Uvo	supply line voltage
DM4 698W	Pw1Of	0	±100%	PWM1 analog output	Output offset compensation parameters	
DM5 700W	Pw2Of	0	±100%	PWM2 analog output		
DM6 702W	Pw3Of	0	±100%	PWM3 analog output		
DM7 704W	Pw1_G	100 %	±200%	PWM1 analog output	Parameters for the output recalibration	
DM8 706W	Pw2_G	100 %	±200%	PWM2 analog output		
DM9 708W	Pw3_G	100 %	±200%	PWM3 analog output		

Code	Name	Default	Values	Description
			(xi)	Group N - DIGITAL INPUTS

13 digital inputs are available (START➔XM1-13, RAMP➔XM1-14, INTREF1➔XM1-15,INTREF2➔XM1-16, COM1➔XM1-17, COM2➔XM1-18, COM3➔XM1-19, KP➔XM1-20,REMOTE RESET➔XM1-21 on the control board and COM4➔XM6-1/2, COM5➔XM6-3/4,COM6➔XM6-5/6, COM7➔XM6-7/8 on the SPDIO optional board). The 7 parameters in grey are programmable

Nota	This group includes the parameters associated to the following digital inputs:	COM1 terminals XM1-17, 22 COM2 terminals XM1-18, 22 COM3 terminals XM1-19, 22	COM4 connector X1-11 (SPDIO) COM5 connector X1-12 (SPDIO) COM6 connector X1-13 (SPDIO) COM7 connector X1-14 (SPDIO)

DNA 718.0	Com1L	OFF	ON/OFF	COM1 digital input	Parameters for the input logic mode selection:
DNB 718.1	Com2L	OFF	ON/OFF	COM2 digital input	ON active low input
DNC 718.2	Com3L	OFF	ON/OFF	COM3 digital input	OFF active high input
DND 718.3	Com4L	OFF	ON/OFF	COM4 digital input	
DNE 718.4	Com5L	OFF	ON/OFF	COM5 digital input	
DNF 718.5	Com6L	OFF	ON/OFF	COM6 digital input	
DNG 718.6	Com7L	OFF	ON/OFF	COM7 digital input	
DN1 719B	Com1S	OFF		Reserved	
DN2 720B	Com2S	OFF		Reserved	(3) Parameters for the input meaning selection:
DN3 721.B	Com3S	OFF	vedere (3)	COM3 digital input	OFF
DN4 722.B	Com4S	OFF		Reserved	Enable pulses enable
DN5 723.B	Com5S	OFF		Reserved	C_Par 1st set to 2nd set parameters change
DN6 724.B	Com6S	OFF		Reserved	
DN7 725.B	Com7S	OFF		Reserved	

	(xii)	Group O - DIGITAL OUTPUTS	

6 digital programmable outputs are available: 2 open collector on the control board and 6 relay outputs on the SPDIO optional board (OUT3➔XM6-91011, OUT4➔XM6-121314, OUT5➔XM6-151617, OUT6➔XM6-181920).
2 fixed relay are also available: DRIVE OK, No (minimum speed)

Note	This group includes the parameters associated to the following digital outputs:	OUT1 terminals XM1-24, OUT2 terminals XM1-25,	OUT3 connector X1-1 (SPDIO) OUT4 connector X1-2 (SPDIO) OUT5 connector X1-3 (SPDIO) OUT6 connector X1-4 (SPDIO)

DOA 734.2	Out1L	OFF	ON/OFF	OUT1 digital output	
DOB 734.3	Out2L	OFF	ON/OFF	OUT2 digital output	Parameters for the output mode selection:
DOC 734.4	Out3L	OFF	ON/OFF	OUT3 digital output	ON active low output
DOD 734.5	Out4L	OFF	ON/OFF	OUT4 digital output	OFF active high output
DOE 734.6	Out5L	OFF	ON/OFF	OUT5 digital output	
DOF 734.7	Out6L	OFF	ON/OFF	OUT6 digital output	

Code	Name	Default	Values	Description
DO1 735B	Out1S	Alarm	see (4)	OUT1 digital output
DO2 736B	Out2S	Ia_Lim	see (4)	OUT2 digital output
DO3 737B	Out3S	Bridge	see (4)	OUT3 digital output
DO4 738B	Out4S	Enable	see (4)	OUT4 digital output
DO5 739B	Out5S	ErrN=0	see (4)	OUT5 digital output
DO6 740B	Out6S	UdFail	see (4)	OUT5 digital output

(4) Parameters for the output meaning selection:

- Alarm: active alarm
- Ia_Lim: current limit conditions
- Bridge: OFF= FWD bridge; ON = REV bridge
- Enable: pulses enable conditions
- ErrN=0 reached speed (threshold = CB7; isteresys = CB6)
- UdFail: max armature voltage or armature voltage transducer failure.
- DiamEr: diameter evaluation error (WINDER aux. function)
- Ia>CE5: Current threshold exceeded (CE5 parameter)
- N >CE6: Speed threshold exceeded (CE6 parameter; isteresys = CB6)
- ErrP=0 Position error less then threshold (CG5 parameter)
- NregEr: Speed error greater then CF5 par. (in absolute value) for a time greater than CF6 par. Crane application
- *If<CC4* Threshold (param. CC4) field current exceeded. *(The output is high if If < CC4)*
- *T_proof* *Brake Command (torque proof function)*
- *ParSet* *Show the parameters set active (first or second)*
- *Profib* *Digital outputs control. See Appendix F2.5*
- Fixed: Output is constantly low (or high, if DOA...DOF parameters are set to ON).

Group P - MAGNET CHAR.

Note	This group includes the parameters associated to the motor magnetization characteristic, acquired on 8 points. The characteristic is linearly approximated from point to point.			
DP1 744W	M_K1	4.8%	0-100%	
DP2 746W	M_K2	9.7%	0-100%	
DP3 748W	M_K3	14.6%	0-100%	
DP4 750W	M_K4	24.4%	0-100%	
DP5 752W	M_K5	40.0%	0-100%	
DP6 754W	M_K6	70.0%	0-00%	

Group Q - PASSWORD

Note	See paragraph 1.22 section D			
DQ1 756W	PassW	12	0-9999	It allows to use a personal password so to avoid changing or tampering. If DQ1 = 0 the password is not present

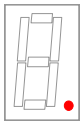
C1 USER INTERFACE

The user can exchange data with the converter through one of the following interfaces:
- a seven segment LED display for basic diagnostics.
- a SPDI1 module for extended diagnostics and for the setting up
- a SPDI2 module similar to the previous one but with the printer output

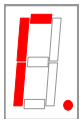


C1.1 Seven segments led display

The display is located on C board; it shows the basic diagnostics information about the Power-up and Reset tests, about the eventual intervention of the protections and the operating state of the converter.
It has the same meaning of the SPDI1 Interface STATUS function, see par. C1.3.1.
The LED shows a letter, or a letter and a figure that alternate by blinking.

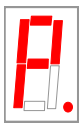


decimal point (flashing) — the converter is properly operating; otherwise the point is always ON or OFF.



TEST (flashing) — converter failure; at least a test failed; the number alternating to the letter is the hexadecimal code of the running or failed test; to restore push RESET button (on C board or terminal XM1-21; another option is to push at same time for a time greater than 1 second the three aligned buttons U, D, MODE on user interface, when provided).

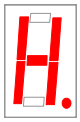
synchronism loss	(T. 0)
phase detector circuit failure	(T. 1)
line voltage beyond tolerance	(T. 2)
line frequency beyond tolerance	(T. 3)
ID converter nr.= 0	(T. 4)
EEPROM failure	(T. 5)
armature current not 0	(T. 6)
RAM failure	(T. 7)



PROTECTION (flashing) — converter failure; at least one protection is active.
The digit alternating to the letter “P” is the hexadecimal code of the active protection.
The active protection is stored (with the exception of Ext_P); to restore push RESET button (on C board or terminal XM1-21; another option is to push at the same time for a time greater than 1 second the three aligned buttons U, D, MODE on user interface, when provided).

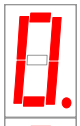
(0) line loss	(P. 0)
(1) external protection	(P. 1)
(2) max instantaneous current	(P. 2)
(3) watchdog intervention	(P. 3)
(4) max armature voltage	(P. 4)
(5) motor field loss	(P. 5)
(6) tacho loss	(P. 6)
(7) blowing loss	(P. 7)
8) motor thermal protection	(P. 8)
(9) converter thermal protection	(P. 9)
(10) serial communication failure	(P. A)
(11) motor max speed	(P. B)
(12) line beyond tolerance	(P. C)
(13) motor stall	(P. D)
(14) leg failure	(P. E)

Every protection is described on the paragraph C1.3.1

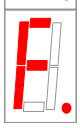


SUPPRESSION (flashing) — pulse suppression condition of the converter; every test good; no active protection. The digit alternating to the letter is the hexadecimal code of the stop origin.

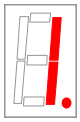
terminal XM1-19 disabled	(H. 0)
terminal XM1-13 disabled	(H. 1)
stop by the serial comm. port	(H. 2)
stop by an optional function	(H. 3)
stop by the internal P.L.C.	(H. 4)



REGULATION — converter in zero speed regulation



FORWARD SPEED — converter in forward speed regulation



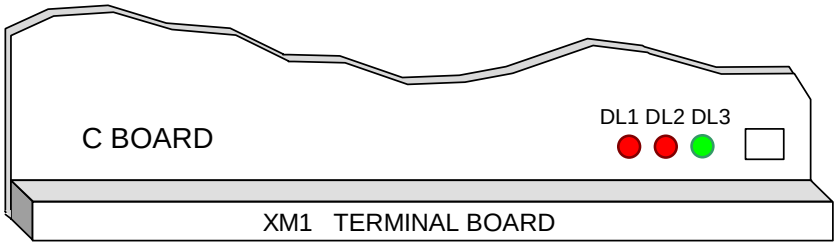
REVERSE SPEED — converter in reverse speed regulation

When the supply is removed from the converter (voluntarily or by a line loss) the first occurred protection is stored. When the supply is restored, the system verifies if any protections are stored; in this case the converter goes in protection conditions displaying the stored protection.
Pressing the reset pushbutton the system will be restored.
The line loss protection intervention is not stored if the converter is in suppression or external protection status. The external protection interventions is not stored.
No protection is stored when the parameter CDA = OFF (Manual IMSPD024K) and jumper JP4 is inserted on pins 2-3 (par. C2.11).

C1.2 Signalling LEDS

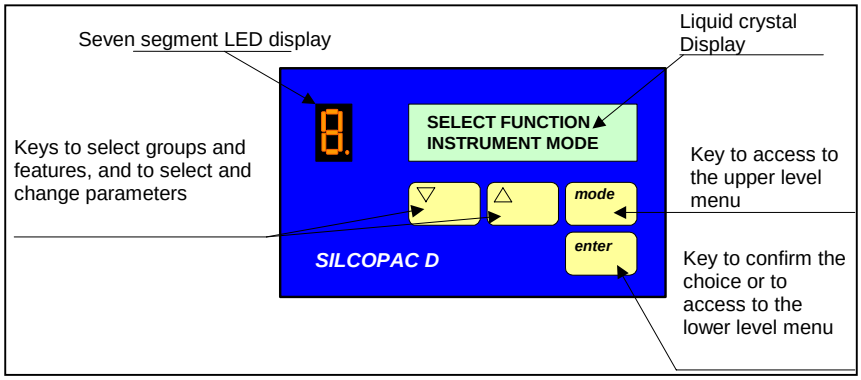
In addition to the seven segments led display an other information on the converter status is given by three leds placed in the lower right side of the “C” board.

DL1 RED: "ON" when the motor is running;
DL2 RED: "ON" when the converter is ready; OFF if there is a protection stored (except external fault protection P-1 Ext_P)
DL3 GREEN: "ON" when the boards are supplied;



C1.3 SPDI1 Interface

The setting up of the digital converter is made through an interface consisting of a liquid crystal display, a seven segments led and four keys called SPDI1 (or SPDI2); this interface can be permanently clamped on the C board and connected to connector X7 of the board via a flat-cable or it can be located up to 2m from the board.
The other possibility is to disconnected and remove the interface at the end of the setting up. The basic diagnostics will be available, in this case, through the 7 segments LED display described at par. C1.1.


Seven segment LED display
Liquid crystal Display
SELECT FUNCTION
INSTRUMENT MODE
Keys to select groups and features, and to select and change parameters
Key to access to the upper level menu
mode
enter
SILCOPAC D
Key to confirm the choice or to access to the lower level menu

Through the interface several functions can be performed, as the determination of the converter setup, the adjustment of proper parameters, the verification of the converter operation, the diagnostics of the failures; in other words the interface is the communication media between the user and the converter.

NOTE The seven segments LED 7 shows, by a letter or by a letter and a digit that blink alternately, the basic diagnostic information described in the paragraph C1.1. If the interface is connected, the seven segment LED placed on the "C" board is disabled.

NOTE The SPDI2 interface includes a CENTRONICS connector for the connection to a parallel printer. (par. C1.3.9). The SPDI1 interface do not includes this connector.

The required functions and parameters are arranged in a menu structure on several hierarchical levels, so to have an easy and tidy communication with the user.
The figure C1.3 shows the structure and, for the first level menu, the list of all the functions provided.

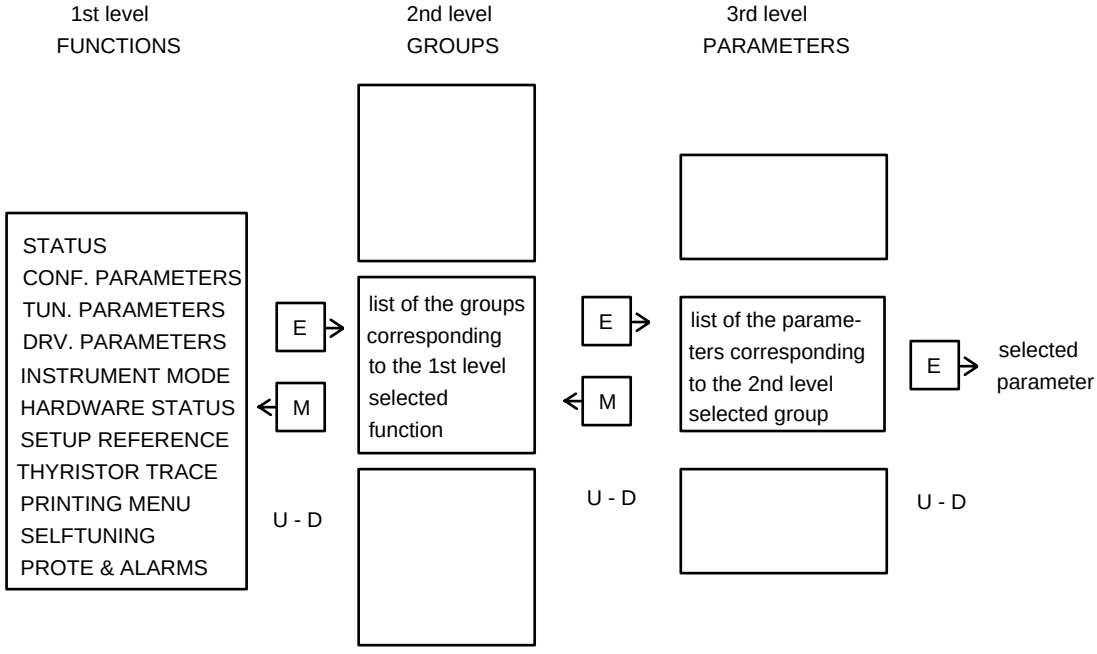


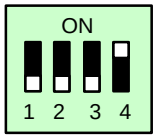
Figure C1.3

NOTE The symbol U-D means that it is required to push the button Up or Down to scroll the list upward or downward, stopping when the desired option appears.
The symbol E means that pushing the ENTER button, the selected option is confirmed and the next level will be displayed.
The symbol M means that pushing the MODE button at any instance, the previous menu level will be displayed.

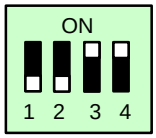
A generic operating sequence, shown with marked lines in the previous figure, is the following:

1. the display shows a first level function (e.g. STATUS); using the buttons U-D, the list of the first level functions is scrolled, stopping on the desired option (e.g. TUNING PARAMETERS);
2. pushing ENTER, the second level will be entered; the display shows the first group of the selected function (e.g. CURRENT REG.);
3. using the buttons U-D the groups list is scrolled, stopping on the chosen option (e.g. SPEED REG.);
4. pushing ENTER button the third level will be entered; the display shows the first parameter of the selected group (e.g. TC1 N_Gp1);
5. using the buttons U-D the parameters list is scrolled, stopping on the desired option (e.g. TC3 N_Gd1);
6. pushing ENTER button the selected parameter is confirmed.

The SPDI1 interface has four DIP SWITCHES, arranged on the rear of the unit, that must be configured as following:
1 = OFF, 2 = OFF, 3 = OFF, 4 = ON



The SPDI2 interface has four DIP SWITCHES arranged on the rear of the unit, that must be configured as following:
1 = OFF, 2 = OFF, 3 = ON, 4 = ON



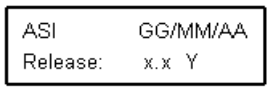
Near to the dip-switch there is a trimmer for the contrast control of the liquid crystal display.

The following pages report the full description of all the existing functions.

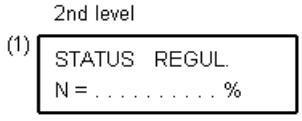
C1.3.1 Status

This function shows information about the Power-up or the Reset test, about the protections and about the operating status of the converter.

<u>At Power-up or at Reset</u>
the display shows the date and the software release for 5 seconds:
y=E: ENHANCED release;
y <> (B or E): CUSTOM release.
Pushing the MODE button the delay and the following view are skipped, and the first level will be immediately entered.



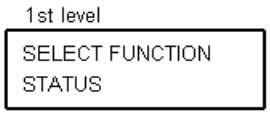
after 5 seconds the display shows:
the displayed variable is selected through the DG4 parameter.



push MODE to go back to the first level:



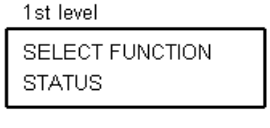
the display shows:



Push the U-D buttons to scroll the other functions.

U - D

<u>Normal operation</u>

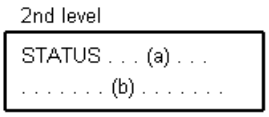


select the STATUS function using U-D buttons

U - D

pushing ENTER button





the display shows an item of the list (a) and an item of the list (b); if the item (a) is REGUL., the item (b) is selected through the DG4 parameter as in (1).

list (a)		list (b)			
TEST	locked converter;	SYNCR. NOT PRES.	synchronism loss		cod.0
(#)	at least 1 test failure	PHASES ERROR	phase detector circuit failure		cod.1
		LINE VOLT. ERROR	line voltage beyond tolerance		cod.2
		LINE FREQ. ERROR	line frequency beyond tolerance		cod.3
		ENTER PAR. DA1	converter ident. number = 0		cod.4
		EEPROM FAILED	EEPROM failure		cod.5
		Ia <> 0	not null armature current		cod.6
		RAM FAILED	RAM failure		cod.7
PROTE.	locked converter;	PROTECTION MainF	line loss	(0)	cod.0
(#)	at least 1 protection	PROTECTION Ext_P	external protection	(1)	cod.1
(++)	active	PROTECTION IOC	max instantaneous current	(2)	cod.2
		WATCHDOG Sync_L	watchdog active	(3.1)	cod.3
		WATCHDOG Sync_F	watchdog active	(3.2)	cod.3
		WATCHDOG Eepr_F	watchdog active	(3.3)	cod.3
		WATCHDOG HwWdog	watchdog active	(3.4)	cod.3
		WATCHDOG Reset	watchdog active	(3.5)	cod.3
		WATCHDOG ParDJ8	watchdog active	(3.6)	cod.3
		WATCHDOG Eep_SP	watchdog active	(3.7)	cod.3
		WATCHDOG AInp_F	watchdog active	(3.8)	cod.3
		WATCHDOG N<>0	watchdog active	(3.10)	cod.3
		WATCHDOG alfa<50	watchdog active	(3.11)	cod.3
		WATCHDOG MaxS	watchdog active	(3.12)	cod.3
		PROTECTION Ud_F	max armature voltage	(4)	cod.4
		PROTECTION If_F	motor field loss	(5)	cod.5
		PROTECTION TachF	tacho loss	(6)	cod.6
		PROTECTION Fan_F	blowing loss	(7)	cod.7
		PROTECTION MotOh	motor over temperature	(8)	cod.8
		PROTECTION ConOh	converter over temperature	(9)	cod.9
		PROTECTION Ser_F	serial comm. loss	(10)	cod.A
		PROTECTION NMax	max motor speed	(11)	cod.B
		PROTECTION UvOut	line volt. beyond toler.	(12)	cod.C
		PROTECTION Stale	motor in stall cond.	(13)	cod.D
		PROTECTION Leg_F	leg failure	(14)	cod.E
SUPPR.	pulse suppression;	Disable HW - Com3	terminal XM1-19 disabled		cod.0
(#)	all tests passed;	Disable HW - M13	terminal XM1-13 disabled		cod.1
	no protections active	Disable Serial	serial generated disabling		cod.2
		Disable Opt.Fun	opt. funct. generated disabl.		cod.3
REGUL.	converter regulating	Aux1..... %	first aux. variable		
(')	with run consent	Aux2..... %	second aux. variable		
		Aux3..... %	third aux. variable		
		No =..... %....(fs)..... '	speed tolerance (rpm)		
		N =..... %....(fs)..... '	speed feedback (rpm)		
		Iao =..... %....(fs)..... A	armature current reference		
		Ia =..... %....(fs)..... A	armature current feedback		
		Ud =..... %....(fs)..... V	armature voltage		
		Flu =..... %	motor flux		
		Ifo =..... %....(fs)..... A	field current reference		
		If =..... %....(fs)..... A	field current feedback		
		Uvo =..... %....(fs)..... V	line voltage		
		alfa =.....'	thyristor firing delay (electr. degree)		

NOTE

The % values of list (b), with the exception of Aux1, Aux2, Aux3, Flu, can be modified in absolute value through the CD2 parameter in the list (b): (fs) = full scale value equivalent to 100%

beside to the items in list (a) can appear: A if an alarm is active

I_L if the converter is in current limit conditions;

the threshold to signal current limit conditions can be programmed through par. CD9.

NOTE (#)

The hexadecimal code related to the list (b) is available on the serial communication interface to be transmitted to the eventual supervisor control system (in this case the serial interface must be enabled).

NOTE (++)

Each intervention can be defined by the Drive Parameters as follows:
protection: if the intervention is reported and the converter is stopped (DCx parameter of group DC);
alarm: if the intervention is reported without the stop of the converter (DDy parameter of group DD);
x, y identify the active protection or alarm (e.g. DCA = line loss).

	DCx	DDy	
1th	OFF	OFF	intervention disabled
2th	OFF	ON	intervention enabled as alarm
3th	ON	OFF	intervention enabled as protection
4th	ON	ON	intervention enabled as both protection and alarm

WARNING

status 3rd is allowable for intervention (0), (1), (2), (3), (10) only.
status 2nd and status 4th are not allowable for interventions (4), (5), (11), (12), (14).

NOTE (")

The displayed item must be previously selected through the DG4 parameter.

(0) The system forces the converter to the max delay, followed by a pulses suppression condition.

This hardware protection cannot be disabled.

(1) An external protection is active opening the terminal XM1-20 and disabling the converter; the relay K2 (converter ready) doesn't fall. The intervention is not internally stored, so the converter will be re-enabled when the protection loss closes again the terminal XM1-20.

This hardware protection cannot be disabled.

(2) The intervention of this protection occurs when the voltage drop on the CT load resistor rises beyond 6.3 V; see par. C3.1.3.

This hardware protection cannot be disabled.

(3) The Watchdog protection operation depends on the following causes:

(3.1) Synchronism loss during a time greater than 100 ms. This hardware protection cannot be disabled.

(3.2) Synchronism loss due to an interference. This hardware protection cannot be disabled.

(3.3) EEPROM failure or the jumper JP4 is not in place: is it not possible to store the parameters. This hardware protection cannot be disabled.

(3.4) Micro controller supervision intervention. This hardware protection cannot be disabled.

(3.5) Reset due to an interference. This hardware protection cannot be disabled.

(3.6) A current sample value was higher than 100 %. Decrease the DJ8 parameter value; see par. C3.3. This hardware protection cannot be disabled.

(3.7) EEPROM self-protection against a writing overflow failure. This hardware protection cannot be disabled.

(3.8) Too large offset value at one or more analog channels. C board likely failure.

(3.10) The motor is running during the self tuning procedure; the excitation current is not zero.

(3.11) The alfa firing angle value evaluated during the current loop self tuning is lower than 50 electrical degrees; see par. C2.10.1 SELF TUNING.

(3.12) During the CURRENT SELFTUNING procedure, the intervention did not succeed in carrying out the calibration of the current loop; do it manually.

(4) The maximum threshold value can be adjusted through the DC5 parameter. The intervention may also depend on the transducer failure; in this case the protection becomes active if the motor speed (parameter DB7), while the transducer signals a voltage lower than 50% of the nominal value.

(5) The intervention also may depend on the exciter failure. The minimum threshold value can be adjusted through the DC3 parameter.

(6) The protection will be active if the armature voltage exceeds 50% of the nominal value, at null tacho voltage.

The protection will be active also if the tacho voltage has reversed polarity.

(7) It warns the intervention of the converter heat sink thermostat.

(8) For proper operation of this protection , the DB6 parameter has to be programmed:

DB6 = $100 * Ia_N / Ia_M$ Ia_N = nominal armature current; Ia_M = max armature current, see par. C2.3

(9) For proper operation of this protection, the following parameters have to be programmed:

DA3 = converter size DB3 = Ia_M

(10) The protection become active if the serial communication is lost during a time higher than the value set through the DC7 parameter (see CD3 parameter too) . At power-up the time is set to 10 minutes. This protection is active only if the serial interface is enabled. See note *.

WARNING: Disabling of the serial link loss protection requires a particular care, should the converter receive current or speed references from the serial link. In this case, when the serial link loss occurs, the converter continues to work according to the last reference received : therefore, the user must carry out the operations and use as reference the signals sent by one of the logic outputs configured as "Alarm" (see Drive parameters description, groups D and O).

(11) The intervention threshold can be tuned through the DC4 parameter.

(12) The minimum intervention threshold can be adjusted by the DC1 parameter, the maximum one through the DC2 parameter.

(13) The intervention happens if the stall time, in motor current limit conditions, exceeds the value set by the DC6 parameter.
The protection will not be active if the current limit is lower than 25% of Ia_N. The Ia_N value can be set by the DB6 parameter.

(14) This protection is operated when at least two phases feeding the bridge are missing (fuses damaged or open contactors)
More precisely the protection will be active when the following condition will be true:
armature current Ia = 0; armature voltage Va = 0; phase shift angle alfa < 80 °.
For proper operation the DA2 parameter has to be programmed.

NOTE (*) When the serial link with a Personal Computer (RS 232) is enabled and parameter CA1 <> Serial and parameter CB1 <> Serial, the serial link loss protection is not enabled. If the conditions for the protection intervention occur, the possibility to change the serial link parameters is disabled; to re-enable it, reset the converter.

When the supply is removed from the converter (voluntarily or by a line loss) the first occurred protection is stored. When the supply is restored, the system verifies if any protections are stored; in this case the converter goes in protection conditions displaying the stored protection. Pressing the reset pushbutton the system will be restored. The line loss protection intervention is not stored if the converter is in suppression or external protection status. The external protection intervention is not stored.
No protection is stored when the parameter CDA = OFF and jumper JP4 is inserted on pins 2-3 (paragraph.C3.8).

C1.3.2 Configuration parameters

This function configures the system, sets the choices made about the converter structure; for example, speed feedback from tacho generator or encoder, current reference from speed regulator or from external device, etc.

using buttons U-D
select the Configuration Parameters function

press ENTER

before accessing to the 2nd level, the password is requested at step (1) (this is mandatory only if one wants to modify the value of a parameter in (2); the password value is 12)

press ENTER to access to the 2nd level

through buttons U-D select an item of the list (a)

press ENTER to access to the 3rd level

using buttons U-D select a parameter of the list (b)

press ENTER to confirm the selected parameter

through buttons U-D enter the desired value in (2)

press ENTER to confirm the value and to return to 3rd level; the new value will be stored in the EEPROM

if the password entered in (1) is not correct, pressing ENTER in (3) the display shows :

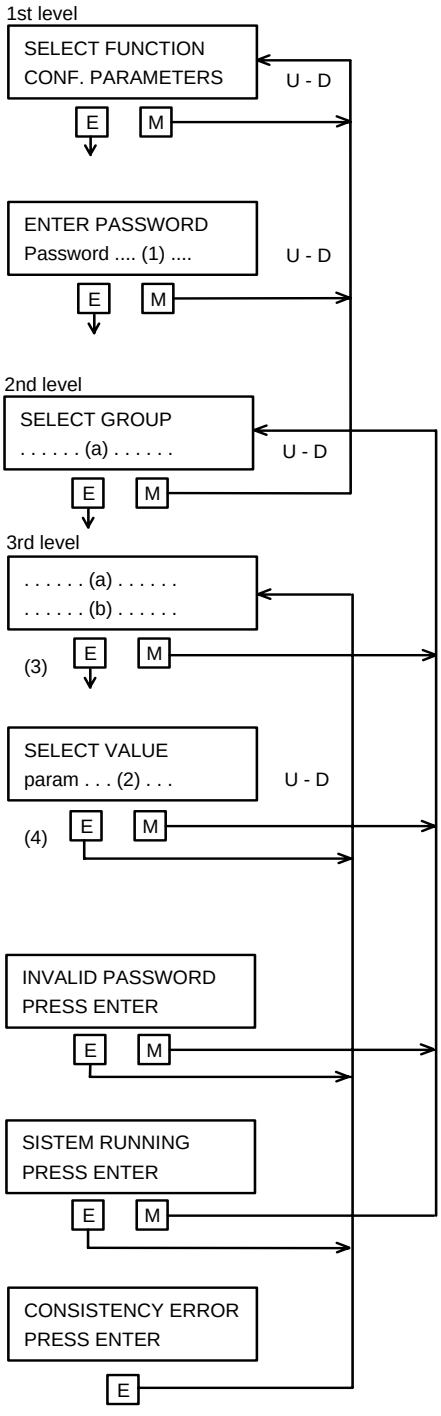
press ENTER to return to 3rd level

if the system is regulating and the parameter is protected, pressing ENTER in (3) the display shows:

press ENTER to return to 3rd level

if the system cannot accept the value entered in (2), pressing ENTER in (4) the display shows:

press ENTER to return to 3rd level



List (a)	list (b)
A - CURRENT REG.	parameters of the armature current regulator
B - SPEED REG.	parameters of the speed regulator
C - E.M.F.REG.	parameters of the motor E.M. force regulator
D - MISCELLANEOUS	various parameters
E - AUX. FUNCT. 1	1st aux functions group
F - AUX. FUNCT. 2	2nd aux functions

C1.3.3 Tuning parameters

This function tunes the system, sets the tuning parameters values of each regulator included in the converter, so to meet the specifications requested by the actual application; e.g. tuning of the current regulator, of the speed regulator, etc..

using buttons U-D
select the Tuning Parameters function

press ENTER

before accessing to the 2nd level, the password is requested at step (1) (this is mandatory only if one wants to modify the value of a parameter in (2) ; the password value is 12)

press ENTER to access to the 2nd level

through buttons U-D select an item of the list (a)

press ENTER to access to the 3rd level

using buttons U-D select a parameter of the list (b)

press ENTER to confirm the selected parameter

through buttons U-D enter the desired value in (2)

press ENTER to confirm the value and to return to 3rd level; the new value will be stored in the EEPROM

if the password entered in (1) is not correct, pressing ENTER in (3) the display shows:

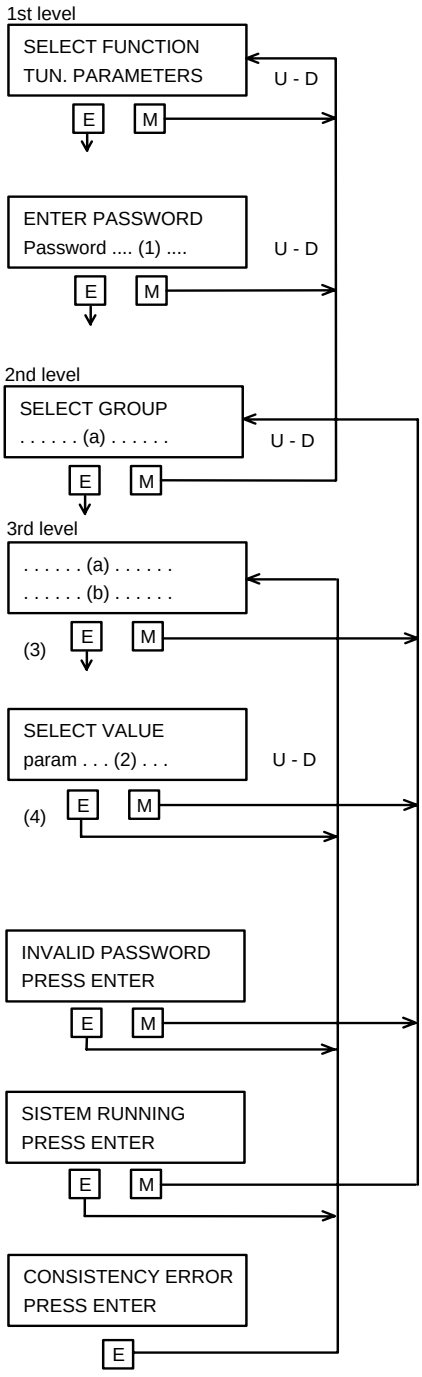
press ENTER to return to 3rd level

if the system is regulating and the parameter is protected, pressing ENTER in (3) the display shows:

press ENTER to return to 3rd level

if the system cannot accept the value entered in (2), pressing ENTER in (4) the display shows:

press ENTER to return to 3rd level



List (a)	List (b)	
A - CURRENT REG.	1st parameters set of the armature current regulator	(5)
B - ALT. CURRENT	2nd parameters set of the armature current regulator	(6)
C - SPEED REG.	1st parameters set of the motor speed regulator	(5)
D - ALT. SPEED	2nd parameters set of the motor speed regulator	(6)
E - RAMP	1st parameters set of the ramp in series to the speed ref.	(5)
F - ALT. RAMP	2nd parameters set of the ramp in series to the speed ref.	(6)
G - E.M.F. REG.	parameters of the motor E.M. force regulator	

(5) the parameters of the 1st set are always active, with the exception of the following case (6), when they are replaced by the parameters of the 2nd set.

(6) the parameters of the 2nd set are arranged to replace those of the 1st set assigning to the DN3 parameter the value C_Par; the replacement happens when the terminal XM1-19 (COM3) becomes active; disabling XM1-19 the 1st set will be enabled again.

C1.3.4 Drive parameters

This function sets up the system, sets the choices made to match the converter performances to the installation features; e.g. when a certain alarm or protection is required, when a serial communication has to be provided, which inputs or outputs are to be used, etc.

using buttons U-D
select the Drive Parameters function

press ENTER

before accessing to the 2nd level, the password is requested at step (1) (this is mandatory only if one wants to modify the value of a parameter in (2); the password value is 12)

press ENTER to access to the 2nd level

through buttons U-D select an item of the list (a)

press ENTER to access to the 3rd level

using buttons U-D select a parameter of the list (b)

press ENTER to confirm the selected parameter

through buttons U-D enter the desired value in (2)

press ENTER to confirm the value and to return to 3rd level; the new value will be store in the EEPROM

if the password entered in (1) is not correct, pressing ENTER in (3) the display shows:

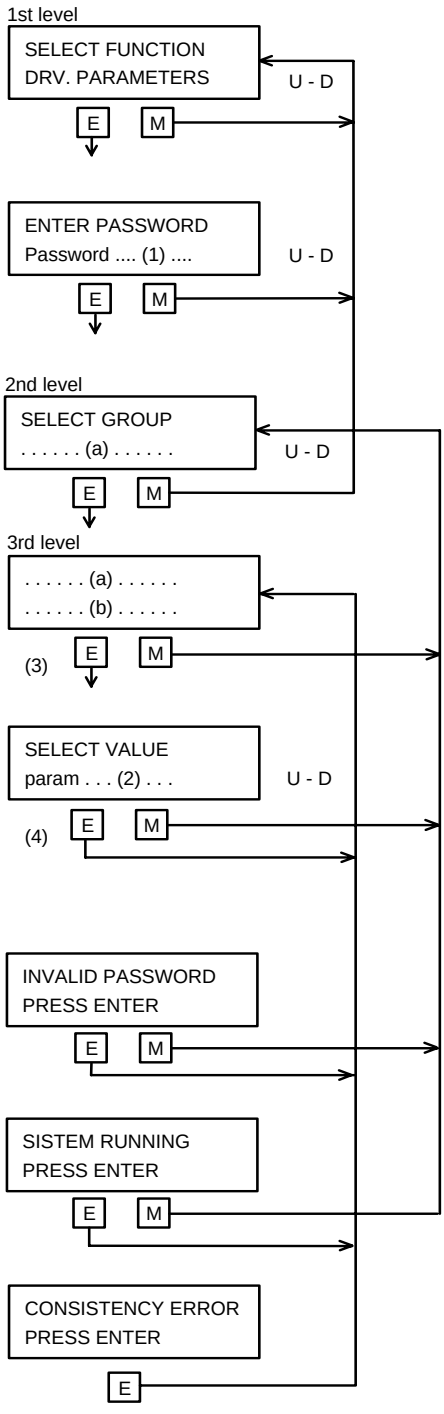
press ENTER to return to 3rd level

if the system is regulating and the parameter is protected, pressing ENTER in (3) the display shows:

press ENTER to return to 3rd level

if the system cannot accept the value entered in (2), pressing ENTER in (4) the display shows:

press ENTER to return to 3rd level



List (a)	List (b)
A DRIVE IDENTIF.	see appendix F
B. DRIVE I/O	“
C. PROTECTIONS	“
D. ALARMS	“
E. SERIAL LINK	“
F SERIAL DATA	“
G DIAGNOSTICS	“
H ANALOG INP. OFS	“

“

List (a)	List (b)
J. ANALOG INP. GN.	see appendix F
K. ANALOG INP. FLT	“
L. ANALOG INP. ABS	“
M. ANALOG OUTPUTS	“
N. DIGITAL INPUTS	“
O. DIGITAL OUTPUTS	“
P. MAGNET. CHAR.	“
Q. PASSWORD	“

C1.3.5 Instrument mode

This function allows the use of the display as a measurement instrument, to display continuously two variables. List (a) shows the variables that can be displayed.

using buttons U-D
select the Instrument Mode function

press ENTER to access to the 2nd level

the display shows two items of list (a) (A)

press ENTER if the items are not those wanted

through buttons U-D select an item of list (c)

pressing ENTER the variable 1 is confirmed

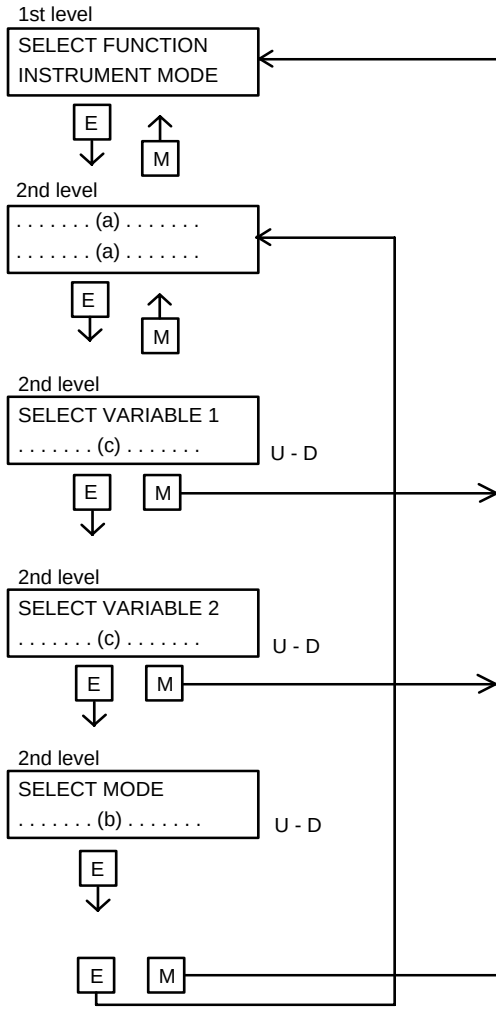
using buttons U-D select another item of list (c)

pressing ENTER the variable 2 is confirmed

through buttons U-D select an item of list (b)

pressing ENTER the displaying mode is confirmed

pressing ENTER again the choices made are displayed, with the possibility to repeat the selection cycle; otherwise return to the 1st level pressing MODE



(A) see par. 1.2.7

List (a)		List (c)
Aux1..... %	1st aux variable	Aux1 = Aux var.1
Aux2..... %	2nd aux variable	Aux2 = Aux var.2
Aux3..... %	3rd aux variable	Aux3 = Aux var.3
No =..... %....(fs)..... '	speed reference (rpm	No = speed ref.
N =..... %....(fs)..... '	speed feedback (rpm)	N = speed
Iao =..... %....(fs)..... A	armature current reference	Iao = arm. curr. ref.
Ia =..... %....(fs)..... A	armature current feedback	Ia = arm. curr.
Ud =..... %....(fs)..... V	armature voltage	Ud = arm. volt.
Flu =..... %	motor flux	Flu = flux
Ifo =..... %....(fs)..... A	field current reference	Ifo = field cur. rf
If =..... %....(fs)..... A	field current feedback	If = field curr.
Uvo =..... %....(fs)..... V	line voltage	Uvo = line voltage
alfa =.....'	thyristors firing angle (electr. Degrees)	alfa = firing angle

NOTE: the % values of list (a), with the exception of Aux1, Aux2, Aux3, Flu, can be modified in real values through the CD2 parameter.
(fs) = full scale value corresponding to 100 %

List (b)
DIGIT NUMBERS the variables selected in (1) and (2) are displayed in digits with 0.1% precision

NOTE : If the DGC parameter is set ON, whenever we have POWER ON or after every reset, the INSTRUMENT MODE (level 2, point A) is shown instead of the frame provided by the STATUS function.

C1.3.6 Hardware status

This function displays the digital inputs and outputs status (ON or OFF), and the analog inputs and outputs value (as % of the full scale value).

using buttons U-D
select the Hardware Status function

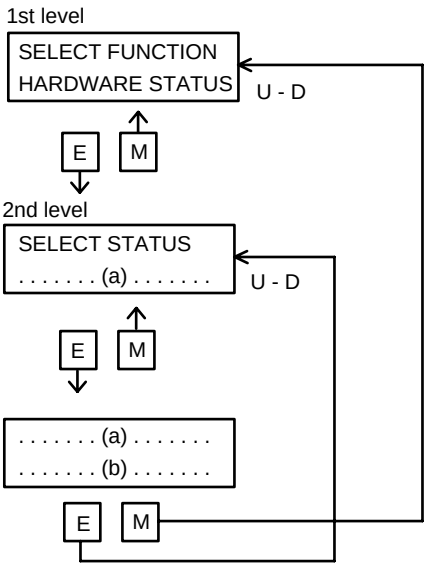
press ENTER to access to the 2nd level

using buttons U-D select an item of list (a)

press ENTER to confirm the choice

using buttons U-D the items of list (b) are displayed

press ENTER to return to the 2nd level or
press MODE to return to the 1st level



List (a)		List (b) (++)		
LOGIC INPUT	M13	Start	... (1)...	motor START
	M14	Ramp	... (1)...	speed ref. ramp insertion
	M15	IntRef1	... (1)...	1st internal speed ref. insertion
	M16	IntRef2	... (1)...	2nd internal speed ref. insertion
	M17	Com1	... (1)...	programmable logic command 1
	M18	Com2	... (1)...	programmable logic command 2
	M19	Com3	... (1)...	programmable logic command 3
	X1-11	Com4	... (1)...	programmable logic command 4
	X1-12	Com5	... (1)...	programmable logic command 5
	X1-13	Com6	... (1)...	programmable logic command 6
	X1-14	Com7	... (1)...	programmable logic command 7
	M20	Ext_P	... (1)...	external protection intervention
LOGIC OUTPUT	M1/2	K1	... (1)...	zero speed K1 relay
	M3/4	K2	... (1)...	ready converter K2 relay
	M24	OUT1	... (1)...	programmable logic output 1
	M25	OUT2	... (1)...	programmable logic output 2
	X1-1	OUT3	... (1)...	programmable logic output 3
	X1-2	OUT4	... (1)...	programmable logic output 4
	X1-3	OUT5	... (1)...	programmable logic output 5
	X1-4	OUT6	... (1)...	programmable logic output 6
ANALOG INPUT	M26	N =.....%		motor speed (#)
	M28	If =.....%		motor excitation current
	M29	Ean1 =.....%		1st programmable input Ean1
	M30	Ean2 =.....%		2nd programmable input Ean2
	M32	Ud =.....%		armature voltage
	M33	No =.....%		motor speed reference
	Uvo	.....%		line voltage
	Ia	.....%		armature current feedback
ANALOG OUTPUT	M37	Pwm1		programmable analog output 1
	M39	Pwm2		programmable analog output 2
	M40	Pwm3		programmable analog output 3

NOTES :

(++) list (b) : (1) = ON or OFF
terminal XM1... is listed as M...

(#) at each analog input a voltage signal in the range ± 10 V can be applied; the signal is displayed as percent value: ± 10 V correspond to ± 100 %.

Warning: All analog inputs, with the exception of M32, are programmable inputs, so they can be put in relationship to variables other than those shown in list (b) (for some aux functions only); the variables in this list are those more habitually used.

C1.3.7 Set up reference

This function allows to set some internal programmable references used by the regulation loops and to verify the consequence on the other system variables; the function is useful during the setting up sequence and during the diagnostics.

through buttons U-D
select the Setup Reference function

press ENTER to access to the 2º level

using buttons U-D, in disabled converter conditions,
select from list (a), 1st or 2nd subset, the desired
reference type

if the selected type from list (a) is an item of the 2nd subset,
press ENTER to access to the 3rd level; enable the converter (B)

using buttons U-D set in (b) the desired value to apply to
reference before selected (#).

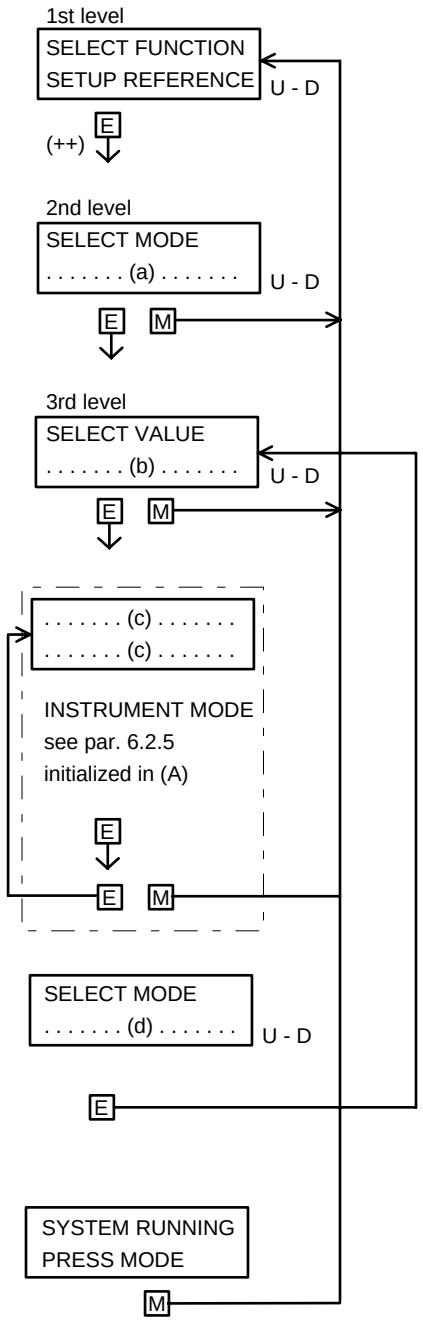
pressing ENTER the selected reference will be step activated with
the (b) pre-set value; contemporary the display shows in (A)
two variables of list (c) to verify the step consequence; at the same
time the THYRISTOR TRACE and the DRIVE TRACE (see par. 1.3.3) (A)
will be stored, if DGB parameter is ON, to be successively printed.

pressing MODE the 1st level will be entered and the two TRACE
are restarted.

if the selected type from list (a) is an item of the 1st subset,
pressing ENTER in (B) the display shows:
using buttons U-D select from list (d) the application mode
(fixed or square wave mode) of the already selected reference in (a).
See NOTE (8).

press ENTER to access to the 3rd level.

(++) if the converter is enabled in regulation mode, pressing ENTER the display shows :



(#) if this is CONT.SPEED REF., the value displayed in (b) using buttons U-D will be immediately activated rather than after the confirmation by ENTER button, as for all the other references of the list (b).

List (a)	List (b)	
1st subset		
SPEED REFERENCE	No =.....%....fs.... (rpm)	(1)
VOLTAGE REFER.	Ud =.....%....fs.... V	(2)
FIELD CURR. REF.	Ifo =.....%....fs.... A	(3)
ARM. CURR. REF.	Iao =.....%....fs.... A	(4)
2nd subset		
CONT. SPEED REF.	NoC =.....%....fs.... (rpm)	(5)
ANGLE REF. FRW.	alfa =.....' (electr. degrees)	(6)
ANGLE REF. REV.	alfa =.....' (electr. degrees)	(7)

List (c)

Aux1..... %	1st aux variable
Aux2..... %	2nd aux variable
Aux3..... %	3rd aux variable
No =..... %....(fs)..... '	speed reference (rpm)
N =..... %....(fs)..... '	speed feedback (rpm)
Iao =..... %....(fs)..... A	armature current refer.
Ia =..... %....(fs)..... A	armature current feedback
Ud =..... %....(fs)..... V	armature voltage
Flu =..... %	motor flux
Ifo =..... %....(fs)..... A	field current refer.
If =..... %....(fs)..... A	field current feedback
Uvo =..... %....(fs)..... V	line voltage
alfa =.....'	thyristors firing angle (electr. degrees)

List (d)

FIXED	constant reference
SQUARE WAVE	square wave refer.

Notes: the % value of list (a), with the exception of Aux1, Aux2, Aux3, Flu, may be modified in real values through the CD2 parameter

(fs) = full scale value corresponding to 100 %

(1) speed reference step applied, fixed or square wave mode, before the ramp, to the motor speed regulator, pressing ENTER. Through the DB5 parameter (fs) can be selected.

(2) armature voltage reference step applied, fixed or square wave mode, to the e.m.f. digital regulator of the motor. The motor must be previously set in speed regulation conditions, at a constant value higher than the basic speed; the step should change the armature voltage from a value lower than the nominal voltage (e.g. 70%) and the nominal voltage itself. Through the DB4 parameter (fs) can be selected. The function will be active only if the e.m.f. digital regulation is enabled through the CCA parameter (see the description of the e.m.f. regulator aux function).

(3) motor excitation current reference step applied, fixed or square wave mode, pressing ENTER, to the current analog regulator of the exciter, which can be internal or external to the converter. The motor armature must be disconnected. Through the DB2 parameter (fs) can be selected. The function will be active only if the e.m.f. digital regulation is enabled through the CCA parameter (see the description of the e.m.f. regulator aux function).

(4) motor armature current reference step applied, fixed or square wave mode, pressing ENTER, to the armature current regulator at locked rotor. The motor field must be disconnected. Through the DB3 parameter (fs) can be selected.

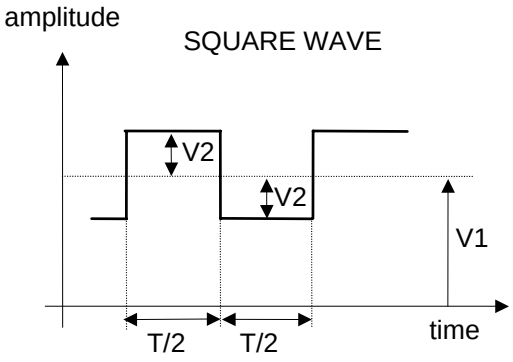
(5) continuous speed reference, so the motor speed follows instant by instant the value set in (b) through buttons U-D. (fs) is selected through the DB5 parameter.

(6) direct step firing, pressing ENTER, of the FWD bridge thyristors at the fixed firing angle; the control is open loops type, so without current and speed regulation. Caution must then be taken to avoid the protections intervention setting angles near to 90 degrees, starting from values greater than 90 and decreasing slowly (e.g. 115, 113, 111, etc.) until the desired response will be obtained.

(7) direct step firing, pressing ENTER, of the REV bridge thyristors at the fixed firing angle; proceed as in (6).

(8) the square wave will be calibrated as shown in the following figure:

V1 = average value, fixed in (b) in the SET UP REFERENCE
V2 = amplitude, fixed through the DG8 parameter
T = period, fixed through the DG9 parameter



C1.3.8 Thyristor trace

This function analyses the current regulator behaviour before and after the occurrence that locked the converter.
During normal operation, five significant variables of the current regulator are logged in memory on each firing of a thyristors pair, every 3.3ms about. The memory stores the last 16 consecutive records, that can be displayed step by step when the converter is locked in a protection or in a suppression status (but in this case only if the DGA parameter was set to ON).
Through the DG3 parameter the record number can be set in the range 2 to 14, after the lock instant.

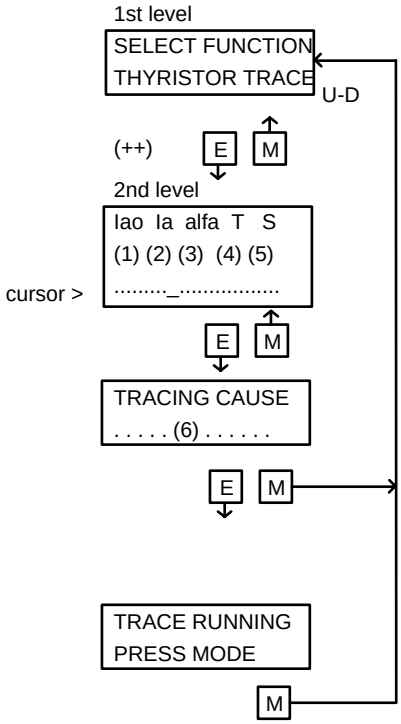
in Trace stop mode conditions, using U-D buttons select the Thyristor Trace function

press ENTER to access to the 2nd level

the display shows the five variables at the lock instant. Using D button the previous instants can be explored; the cursor moves left. Using U button the following instants can be explored; the cursor moves right.

pressing ENTER the lock origin is displayed

see par. C1.3.1 STATUS: the display shows in (6) an item of list (b) in connection to the items PROTE or SUPPR. of list (a).



(++) the Trace stop mode conditions can be programmed through the DGA and DGB parameters; if the Trace acquisition is not stopped the display shows:

Notes:

(1) Ia_O = armature current reference, in % of Ia_M (3 digits plus sign)

(2) Ia = armature current feedback, in % of Ia_M (3 digits plus sign)

(3) alfa = phase angle of the converter, in electrical degrees (3 digits)

(4) T = conducting thyristors pair identified by the following code (1 digit) :

T	Conducting thyristors
1	1-6
2	2-1
3	3-2
4	4-3
5	5-4
6	6-5
*	Invalid records

(5) S = system status identified by the following code (1 digit) :

S	System status
T	Test
S	Suppression
P	Protection
O	zero speed (see CB5, CB6 parameters)
F	FWD speed
I	REV speed

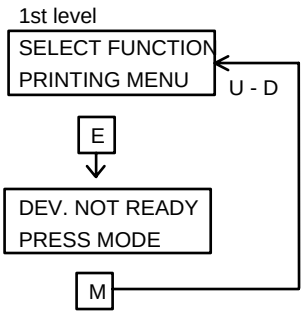
C1.3.9 Printing menu

This function allows to print the traces(Thyristors Trace and Drive Trace) and all parameters (configuration, tuning, drive parameters); the SPDI 2 interface with CENTRONICS connector is required for the parallel printer connection. The SPDI 1 interface doesn't provide this connector.

using buttons U-D
select the Printing Menu function

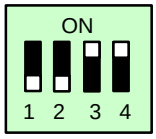
pressing ENTER with SPDI 1 interface

the function will be disabled and the display will show:

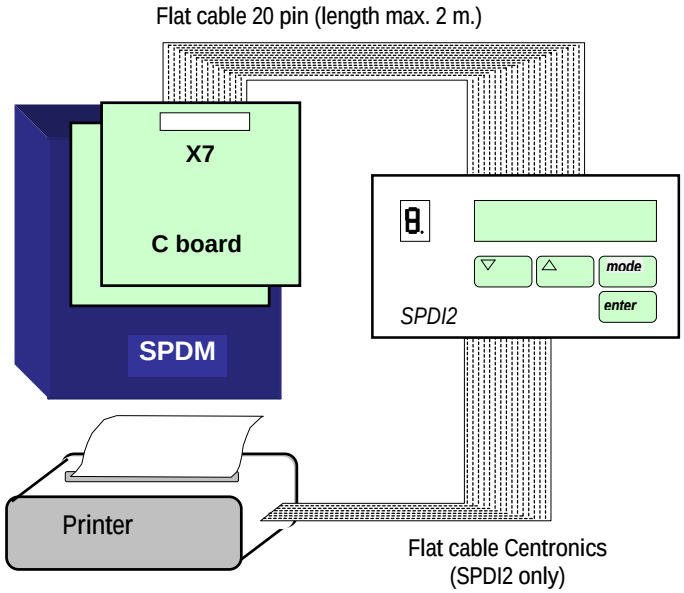


SPDI2 user interface is fully factory set so that it can be connected between a Silcopac D and Centronics parallel printer.
The four DIP SWITCHES arranged on the rear of the unit must have the following configuration:

1 = OFF, 2 = OFF, 3 = ON, 4 = ON



The following picture shows the connection of the SPDI2 Interface to SPDM control board (“C”) and to the printer.



This function allows to copy on a parallel printer connected to the SPDI2 interface, the data and the information of the converter, resumed in list (a) here below described. The Trace prints are very useful for diagnostics and documentation purposes; a Trace is a series of sequential records, executed every fixed time intervals, of a significant data group; these data allow to analyse the converter operation, in order to optimise the converter itself and to put in evidence some eventual failures, going back to the origin.

using buttons U-D select the Printing Menu function

press ENTER to access to the 2nd level

using buttons U-D select from list (a) the desired item (#)

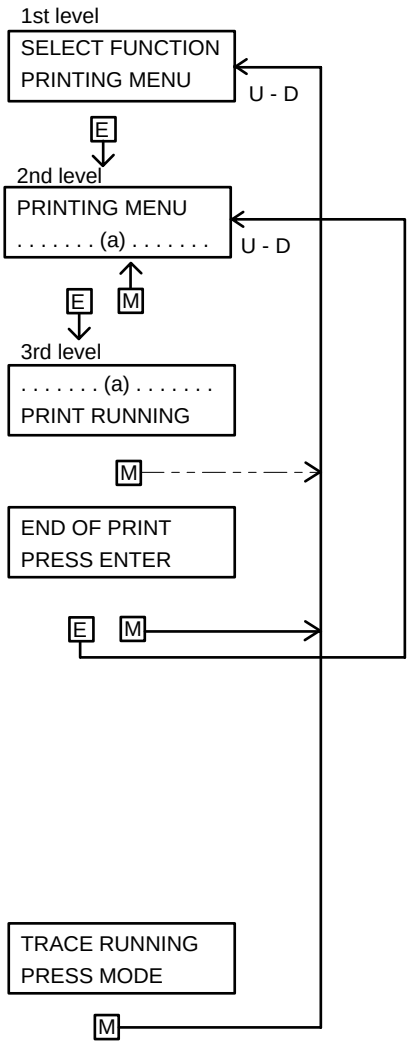
press ENTER to access to the 3rd level

the print of the data associated to the selected item will be enabled

the print can be aborted pressing MODE

the print is terminated by a message (+)

pressing ENTER the 2nd level is resumed
pressing MODE the 1st level is resumed



(+) SYSTEM NUMBER...(1)... ASI...(2)... Release...(3)...
- (1) identification number of the converter
- (2) data (day/month/year)
- (3) software release number, followed by a letter to identify the version (B=BASIC VERSION; E= ENHANCED VERSION; <>B/E=CUSTOM)

(#) if this is THYRISTOR TRACE or DRIVE TRACE the Trace must be in stop mode; see par. DGA and DGB; the display shows:

List (a)

CONF. PARAMETERS configuration parameters ; the present values will be printed; the present values that differ from the default values are marked by an asterisk. A print example is shown in appendix D.

TUN. PARAMETERS regulation parameters; the present values will be printed; the present values that differ from the default values are marked by an asterisk. A print example is shown in appendix E.

DRV. PARAMETERS converter parameters; the present values will be printed; the present values that differ from the default values are marked by an asterisk. A print example is shown in appendix F.

THYRISTOR TRACE if the Trace is in stop mode, the 16 sequential records of the 5 variables of the current regulator described in par. C1.3.8 are printed, numbered from - 8 to + 7 in column N. The record numbered as 0 corresponds to the converter lock instant. The print will be terminated by a message:

(4) ERRORS TRACING CAUSE...(5)...

(4) number of not valid events, marked by an asterisk in column T of the Trace.

(5) see par. C1.3.1 STATUS: an item of list (b) in association with the items PROTE or SUPPR. of list (a) in printed.
If the Trace isn't in stop mode, the printout is disabled; the display shows the message TRACE RUNNING (see par. C1.3.8 note (++)). A Trace example is shown in appendix A.

DRIVE TRACE if the Trace is in stop mode, 50 sequential records of significant data, numbered from -24 to +25, will be printed; the record numbered as 0 corresponds to the converter lock instant; the records numbered as N = * are not valid. Through the DG1 parameter, the records number can be set in the range 5 to 45 after the lock instant. Through the DG2 parameter, the time period between each record can be set.
The printout will be terminated by a message:

(6) ERRORS TRACING CAUSE...(7).... RECORDING TIME...(8)...
Aux1..(9).. Aux2..(10).. Aux3..(11)..

(6)number of not valid events, marked by an asterisk in the first Trace column.

(7) see par. C1.3.1 STATUS: an item of list (b) in association with the items PROTE or SUPPR.of list (a) is printed.

(8) time period between each record and the other.

(9) meaning of the Aux1 variable, selected through the DG5 parameter.

(10) meaning of the Aux2 variable, selected through the DG6 parameter.

(11) meaning of the Aux3 variable, selected through the DG7 parameter.

If the Trace isn't in stop mode, the printout is disabled; the display shows the message TRACE RUNNING (see par. C1.3.8 note (++)).

A Trace example is shown in appendix B.

The data in each record, so for every printout lines, are the following:

STATUS an item of list (a) of par.C1.3.1 STATUS.

PROTECTION 16 bits data, each bit showing if the associated protection is active (bit = 1) or not (bit = 0); the meaning of each bit is shown at the point LEGENDA of this list (a).

LOGIC I/O 16 bits data, each bit showing the logic inputs and outputs status ON (bit = 1) or OFF (bit = 0); the meaning of each bit is shown at the point LEGENDA of this list (a) and in the appendix C.

Particularly the bit 15 (the first on the right side) shows the cumulate status of the alarms:

bit 15 = 0 no alarm active

bit 15 = 1 at least an alarm active

In addition, if bit 15 = 1 the print end message will be completed by the message:

ALARMS... (8)...

(8) 8 bits, see ALARM LEGENDA appendix C.

Note: the above mentioned data are the same before described in par. C1.3.6 HARDWARE STATUS, in list (b) at the items LOGIC INPUT and LOGIC OUTPUT of list (a), with the exception of the last four data OUT3, OUT4, OUT5, OUT6 (see Aux1, Aux2, Aux3).

Aux1	value of the variable selected by the DG5 parameter.
Aux2	value of the variable selected by the DG6 parameter.
Aux3	value of the variable selected by the DG7 parameter.

Note: one of the variables selected through the DG5, DG6, DG7 parameters is the AuxDgn variable, composed by four bits showing the ON or OFF status of the logic outputs OUT3, OUT4, OUT5, OUT6 (see LOGIC I/O and LEGENDA).

No	% speed reference
N	% speed feedback
Iao	armature current reference as % of Ia_M
Ia	armature current feedback as % of Ia_M
Ud	% armature voltage
Flu	% motor flux
Ifo	% field current reference
If	% field current feedback
Uvo	% line voltage
alfa	thyristors firing angle (electr. degrees)

Note: the above mentioned data from Aux 1 to alfa are the same before described in par. C1.3.1 Status, in list (b) at the item REGUL. of list (a). The group of the stored data listed in the DRIVE TRACE is said diagnostics DATABASE and it can be transmitted on the serial communication line.

STOP/PRINT THYR. The THYRISTOR TRACE of this list (a) will be printed, also if the Trace isn't stop mode; in (5) the message PRINTER STOP will be printed to announce that the Trace printout was started by the user. The record N = 0 corresponds to the instant during which the user pressed ENTER. This function is useful to "freeze" the system behaviour when the automatic lock is not provided. This command can be transmitted to the system via the serial link.

STOP/PRINT DRIVE the DRIVE TRACE of this list (a) will be printed, also if the Trace isn't in stop mode; in (5) the Message PRINTER STOP will be printed to announce that the Trace printout was started by the user.
The record N = 0 corresponds to the instant during which the user pressed ENTER. This function is useful to "freeze" the system behaviour when the automatic lock is not provided.
This command can be transmitted to the system via the serial link.

LEGENDA it is an auxiliary table of the DRIVE TRACE that remembers to the user the meaning of the 16 bits of the PROTECTION group, the meaning of the 16 bits of the LOGIC I/O group, the meaning of the 4 bits of the Aux1, Aux2, Aux3 variables (if programmed as AuxDgn) and the meaning of the 8 bits of the ALARMS group. Appendix C shows a printout example.

AUTOPRINT if the converter is in protection conditions (STATUS PROTE), pressing ENTER the system will start the printout of:

THYRISTOR TRACE
DRIVE TRACE

If the converter isn't locked, the system waits for this condition; the display shows:

AUTOPRINT
WAITING FOR STOP

At the protection intervention, the printout will be automatically enabled, without pressing ENTER.

C1.3.10 Self tuning

This functions allows to automatically tune the converter, including the tuning of the current regulator, of the speed regulator and of the motor e.m.f. regulator.

1st level

in disabled converter conditions, using U-D buttons
select the Self tuning function

SELECT FUNCTION
SELFTUNING
U - D

press ENTER to access to the 2nd level

E

2nd level

using buttons U - D select an item of list (a).
Warning : the self tuning will be correct one only if it is executed in the following order:

1st OFFSET SELFTUNING
2nd CURRENT SELFTUNING
3rd SPEED SELFTUNING
4th EMF SELFTUNING

SELECT MODE
. . . . . (a) . . . . . U - D

press ENTER; before pressing see Note (#) in list (a).

E M

The system is ready, waiting for the run consent; the display shows:

. . . . . (a) . . . . .
WAIT. FOR ENABLE

give the run consent enabling the XM1-13 terminal. (++)
The self tuning sequence starts and the display shows:

SELFTUN. RUNNING
PLEASE WAIT

at the end of the sequence the system waits for the run consent removal; the display shows:

CORRECT SELFTUN.
DISABLE DRIVE

disable drive;
the system goes in watchdog protection, disables the interface keyboard and waits for the RESET button ; the display shows:

CORRECT SELFTUN.
RESET DRIVE

press RESET

Reset

press MODE to return to the 1st level
(#) if the converter is not disabled, pressing ENTER the display shows:

M

press MODE to return to the 1st level

SYSTEM RUNNING
PRESS MODE

(++) if during the sequence one of the following events occurs :

1. loss of the run consent;
2. protection intervention, par. C1.3.11, item PROTE of list (a);
3. the storage of the evaluated parameters cannot take place (EEPROM failure: WATCHDOG Eep_SP protection);
4. excessive offset on one or more analog channels (probably C board failure: WATCHDOG AInp_F protection);
5. a current sample is greater than the max value which can be measured (WATCHDOG ParDJ8 protection: the DJ8 parameter has to be decreased; see par. C3.1.4).
6. performing the CURRENT SELFTUN. the motor runs; rotor not locked and field enabled or residual magnetism (WATCHDOG N<>0 protection).
7. the system has reached a firing angle lower than 50 el. degrees (WATCHDOG alfa < 50 protection) the display yshows:
8. MaxS: the self tuning procedure failed (too long). Verify parameters TA3 and TA4.

INVALID SELFTUN.
PRESS MODE

press MODE to return to the 1st level and repeat the sequence

M

List (a)

CURRENT SELFTUN. self tuning of the armature current regulator; the following parameters will be evaluated and placed in active status:

TA1	proportional gain of the regulator
TA2	derivative gain of the regulator
DB9	RI drop across the motor armature

Note : before enabling the function, the following steps are mandatory:

1. verify the proper value of the CT load resistors, see par.C2.3.
2. verify the proper adjustment of the voltage transducer (see par. C2.7.2 , terminal XM1-32).
3. verify the proper set-up of the DB1, DB3, DB4 parameters.
4. remove the motor field physically opening the circuit; set the DCF parameter to OFF to disable the protection "field loss".
5. mechanically lock the motor rotor.
6. verify that TA3 = 100% and TA4 = -100%.

SPEED SELFTUNING self tuning of the motor speed regulator; during the procedure the motor speed goes to its basic value.
The following parameters will be evaluated and placed in active status:

TC1	proportional gain of the regulator
TC2	integral gain of the regulator

Note: before enabling the function, the following steps are mandatory:

1. remove the mechanical lock of the motor rotor.
2. re-enable the excitation circuit; verify that the motor excitation current value be the nominal one; re-enable the "field loss" protection setting the CDF = ON.
3. verify the proper set-up of the DB6, DB7 parameters.
4. verify the proper sign of the speed feedback; verify that the display shows a value equal to 100 * measured speed / full scale speed.
5. connect the motor to the real load; the self tuning executed in motor load-less conditions is not generally valid in real load conditions.

EMF SELFTUNING self tuning of the motor e.m.f. regulator; during the procedure the motor speed goes to its basic value.
The magnetizing characteristic will be detected.

OFFSET SELFTUN. Note: disconnect terminals XM1-26 - 28 - 29 - 30 - 32 - 33 - 34 (analog inputs); connect this terminals again at the end of the procedure.

C1.3.11 Protes & alarms

This function displays the status of all the protections and alarms; the function resets the active alarms.

Remember that each intervention, through the Drive Parameters, may be defined as:
protection: if the intervention is reported and the converter is stopped (DCx parameter of group DC) ;
alarm: if the intervention is reported without the stop of the converter (DDy parameter of group DD) ;
x, y identify the active protection or alarm (e.g. DCA = line loss).

	DCx	DDy	
1st	OFF	OFF	intervention disabled
2nd	OFF	ON	intervention enabled as alarm
3rd	ON	OFF	intervention enabled as protection
4th	ON	ON	intervention enabled as both protection and alarm

Warning: only status 3 is allowable for intervention (0), (1), (2), (3), (10).
status 2 and status 4 are not allowable for interventions (4), (5), (11), (12), (14).

using U-D buttons
select the Protes & Alarms function

press ENTER to access to the 2nd level

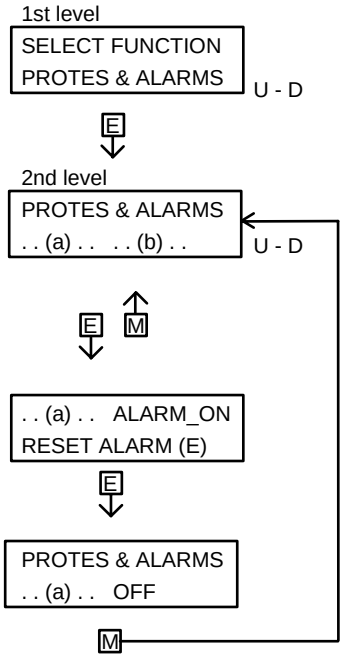
using U-D buttons select in sequence the item of list (a) to examine; in (b) a status of list (b) is reported

if in (b) ALARM_ON is displayed, it is possible to execute the reset; pressing ENTER

the display shows:

press ENTER to reset the alarm; the Reset occurs only if the alarm origin was removed; in this case the display shows:

press MODE to return to the 2nd level



List (a)

MainF	line loss
Ext_P	external protection
IOC	max instantaneous current
WDog	watchdog intervention
Ud_F	max armature voltage
If_F	motor field loss
TachF	tacho generator loss
Fan_F	blowing loss
MotOh	motor over temperature
ConOh	converter over temperature
Ser_F	serial communication loss
NMax	max motor speed
UvOut	line voltage beyond tolerance
Stale	motor stale
Leg_F	leg failure

List (b)

ALARM_ON	active alarm
PROTE_ON	active protection
OFF	enabled alarm/protection but not active
DISABLED	disabled alarm/protection

C1.3.12 PASSWORD (which can be modified)

The software release 2.6 offers to the user the availability to modify the password.
The password is requested when the user wants to modify one of three main groups of parameters (TUNING, CONFIGURATION o DRIVE).
The password is stored in the parameter DQ1 and can assume a value included between 0 and 9999.
To keep the safety, the parameter DQ1 normally is hidden but, in case you forget the password or in case of interventions made by assistance personnel, it can be made visible with the following procedure:

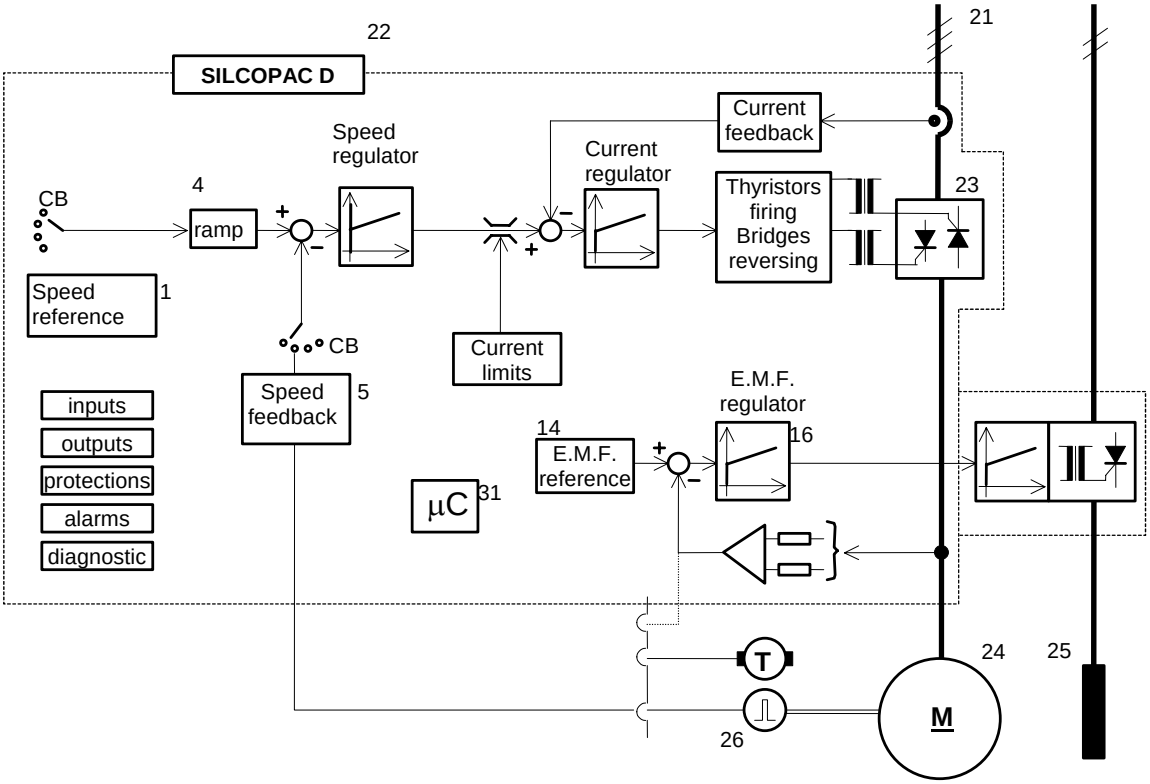
1) Reset the converter keeping pressed the key <ENTER>. this action has the effect to make visible the subgroup Q-SECURITY of the group DRIVE PARAMETERS.
2) Enter the group DRIVE PARAMETERS. Upon the request of the password press <ENTER>.
3) Enter in the subgroup Q-SECURITY: the parameter DQ1 contains the current value of the password.
4) Exit by pressing twice the key <MODE>.
5) Now you can change the parameters introducing the value read in DQ1 (password). One of the parameters which can be modified is the password itself.

After introducing for the first time the correct password, it is not required anymore until the following reset or switching off of the converter
Place DQ1 = 0 the request of the password is disabled.
The value of default of DQ1 is 12.

C2 SETTING UP

The Silcopac D set-up described here refers to the basic diagram shown in the paragraph 7.6A, for a IV quadrant converter, and to the related simplified block diagram.

The following steps are also applicable to for other complex applications that use one more auxiliary functions provided by the software (basic or enhanced); the additional steps to be executed, according to the complete block diagram; are described in the auxiliary user's manual.



If an alarm or a protection occurs during the converter set-up, the SPDI1 user interface displays a message that identifies the intervention cause; section 2 USER INTERFACE describes these messages.

The following functions provide additional help to the setting up:

Set up reference, paragraph C1.3.7;
Thyristor trace , paragrafo C1.3.8;
Printing menu (Drive trace), paragrafo C1.3.9;
Protes & Alarms, paragrafo C1.3.11.

C2.1 Preliminary operations

Before applying power to the Silcopac D, verify the converter and the motor plate data; verify that the power connections and all the terminals wiring are executed as shown by the diagram, and that all the connections and the terminal screws are properly fastened.

Then be sure to verify:
- ☛ the power supply voltage to be applied to terminals AK1, AK3, AK5 at the line breaker closure;.
- ☛ the power supply voltage and the synchronism to be applied to terminal block XM2 on board P;
- ☛ the power supply voltage applied to terminal block XM4 of the motor field exciter (or of the rectifier bridge);
- ☛ the power supply voltage of the blower applied to terminal block XM3.

C2.2 Board P customizing

Before applying power to the Silcopac D, verify the following connections (see par. C2.10):

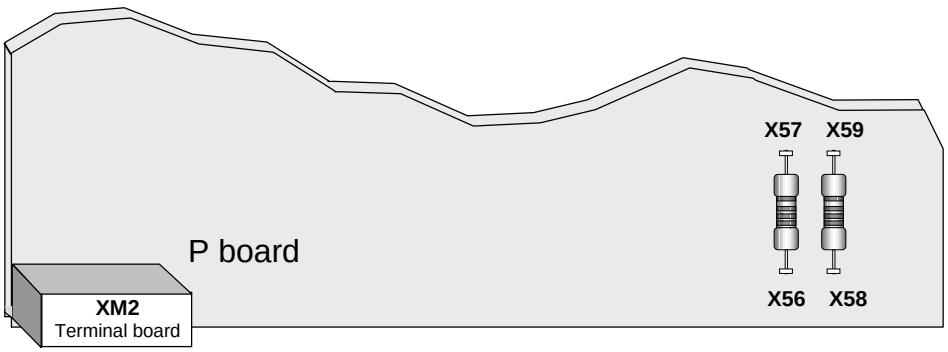
	PR board (SPDM 4 quadrant converter)	PU board (SPDM 2 quadrant converter)
jumper A - B	closed	open
jumper C - D	closed	open
jumper A - C	open	closed
jumper B - D	open	closed
X62 - X63	closed	open
X60 - X61	closed	
X6 - X7	closed	
X1	connected to faston +VA on the snubber board	
X2	connected to faston -VA on the snubber board	
jumper JP1	closed	
X52 - X53	Resistor R176 22k	
X54 - X55	resistor R177 22k	

Verify that:
- CT load resistors R193 (X56 - X57) and R194 (X58 - X59) have the values showed by the paragraph C2.3 and related to the Silcopac D converter type.
- the resistors are well soldered.
- the connection between control terminals (XM2) and power terminals U - AK1, V -AK3, W-AK5 and between SPAE1 exciter terminals (XM4) and control terminals (XM2) U - U, W - W.
- the sense of rotation of the three-phase fan of frames IV and V, and eventually to exchange two phases.

WARNING
- The input power terminals of frame IV are not in sequence; they are installed as following: AK1 – AK5 – AK3

C2.3 Load resistors

The are two load resistors for current transducer (CT), that are mounted on card P, terminals X56, X57 - X58, X59. The value of these parallel connected resistors set the Silcopac D maximum delivered current IaM; the voltage between positive terminal X57 (or X59) and negative terminal X56 (or X58) is proportional to the current: 2Vrms corresponds to the maximum converter current.



In order to program proper current parameters, it is necessary to introduce the following definitions:

I_N	rated current of the converter	Max current value to be delivered in permanent conditions by Silcopac D. This value is the same indicated on the nameplate of the SPDM (example SPDM 850 has an output current IN = 850 A.
Ia_M	max working current of the motor (corrente di fondo scala del convertitore)	This value is settled by ohmic value of CT the load resistors.
Ia_T	motor current name plate	max current to be absorbed in permanent conditions by the motor.

NOTE

The Ia_M current can be higher than the I_N, provided that is in accordance with the load cycles provided in the paragraph A8.
The Ia_M current must lower of the maximum overload current of the motor

Knowing the maximum motor working current, the ohmic value of the load resistor may be calculated with the following relationship:

$$R_P = 2 \cdot \frac{N_S}{I a_M} \qquad (1)$$

where $R_P = \frac{R_{x56 - x57} \cdot R_{x58 - x59}}{R_{x56 - x57} + R_{x58 - x59}}$ [Ω] and N_S = CT turns ratio

The table shows the Rx56 - 57, Rx58 - x59 resistor values mounted in the factory, together with the values obtained by applying the ratio (#), in which it is supposed that the maximum current output laM is equal to the IN nominal current of the converter.

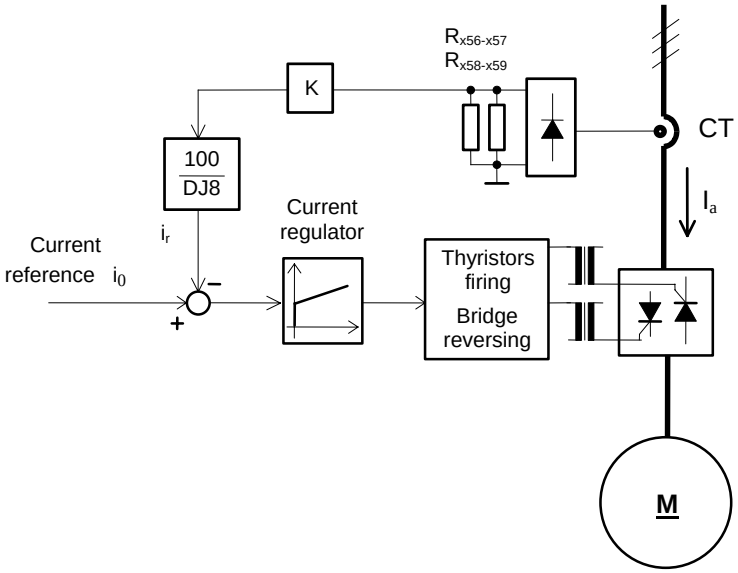
Table C2.3

Silcopac D Type	Frame	$R_{X56 - X57}$ Ω / W	$R_{X58 - X59}$ Ω / W	Ns 2000
SPDM030	I	150 / 0.5	1200 / 0.5	2000
SPDM060	I	120 / 0.5	150 / 0.5	2000
SPDM080	I	100 / 0.5	100 / 0.5	2000
SPDM110	I	39 / 0.5	560 / 0.5	2000
SPDM160	II	27 / 0.5	330 / 0.5	2000
SPDM200	II	22 / 0.5	220 / 0.5	2000
SPDM260	II	18 / 0.5	100 / 0.5	2000
SPDM350	II	12 / 1	220 / 0.5	2000
SPDM450	III	12 / 1	33 / 0.5	2000
SPDM500	III	10/ 1	39 / 0.5	2000
SPDM600	III	12 / 1	15 / 0.5	2000
SPDM750	IIIL	12 / 1	100 / 0.5	4000
SPDM850	IIIL	10 / 1	150 / 0.5	4000
SPDM1M0	IIILL	15 / 1	18 / 0.5	4000
SPDM1M1	IIILL	12 / 1	18 / 0.5	4000
SPDM1K5	IV	8.2 / 1	15 / 0.5	4000
SPDM1K6	IV	8.2 / 1	12 / 0.5	4000
SPDM1K7	IV	6.8 / 2	15 / 0.5	4000
SPDM2K1	IV	4.7 / 2	18 / 0.5	4000
SPDM2K2	V	6.8 / 2	39 / 0.5	6400
SPDM2K5	V	10 / 2	10 / 2	6400
SPDM3K1	V	8.2 / 2	8.2 / 2	6400
SPDM3K6	V	3.9 / 2	39 / 0.5	6400
SPDM4K0	V	3.9 / 2	18 / 0.5	6400

NOTE:
The recalibration of the maximum armature current laM, normally executed by replacing $R_{X56 - X57}$ - $R_{X58 - X59}$ with other of different values, shall be now executed also by software through the parameter DJ8; the resistors replacement, in this case, is not needed. The following block diagram shows the DJ8 parameter effect.

The parameter value is:

$$DJ8 = 100 \bullet \frac{IaM}{IN}$$



N.B. As in the case of recalibrating the IaM by replacing the CT load resistors, when you make the recalibration of the armature current by modifying the DJ8 parameter value you must costumize the parameters DB3 and DB6 again using the new correct values.

When possible it is better to set IaM changing the load resistors and to use DJ8 parameter for small adjustement only.
If you change the calibration of Ia_M, either changing the load resistors or the value of DJ8 parameter, it is necessary to set again DB3 and DB6 parameters with the new values.
The following three examples are useful to clarify the problem.
We consider three possible applications:

1) Motor and converter without overload;
2) motor with overload and converter without overload;
3) motored and converter with overload.

Example 1: ☐ motor overload ☐ converter overload

The rated current Ia of the motor is Ia_T = 300 A.
According the table on chapter A3 we select the converter SPDM350 (rated current of the converter I_N = 350 A) .
In order to do not overload the motor it is necessary to limit IaM at 300 A.

First solution: Load resistors change. The table C2.3 shows the CT turns ratio Ns = 2000: by the formula (1) it is possible the calculate the load resistors value:

$$R_p = 2 \cdot \frac{N_s}{Ia_M} = \frac{4000}{300} = 13.3 \quad [\Omega]$$

this ohmic value can be obtained by connecting in parallel one resistor $R_{X56 - X57}$ = 22 Ω with a second resistor $R_{X58 - X59}$ = 33 Ω.

Second solution: Parameter DJ8 change. Instead off changing the load resistors it is possible to adjust the parameter DJ8 according the formula (2):

$$DJ8 = 100 \cdot \frac{Ia_M}{Ia_N} = \frac{300}{350} = 85.7 \quad [\%]$$

In both cases the parameter that must be modified are the following:

DA3 = 350	Current size of the converter.
DB3 = 300	New full scale value of the current.
DB6 = 100%	Motor current in comparison with IaM .

Example 2: ☑ motor overload ☐ converter overload

The rated current Ia of the motor is Ia_T = 700 A and the application needs a current overload of 200% for 5 second every 3 minutes.
The converter for these application must be able to supply 1400A without overload. According to the table of the chapter A3 we select the converter SPDM1K5 (rated current of the converter IN = 1500A).
The rated current required is IaM = 1400 A.

First solution:: Load resistors change. The table C2.3 shows the CT turns ratio Ns = 4000: by the formula (1) it is possible the calculate the load resistors value:

$$R_p = 2 \cdot \frac{N_s}{Ia_M} = \frac{8000}{1400} = 5.7 \quad [\Omega]$$

this ohmic value can be obtained by connecting in parallel one resistor $R_{X56 - X57}$ = 8,2 Ω with a second resistor $R_{X58 - X59}$ = 18 Ω.

Second solution: Parameter DJ8 change. Instead off changing the load resistors it is possible to adjust the parameter DJ8 according the formula (2):

$$DJ8 = 100 \cdot \frac{Ia_M}{Ia_N} = \frac{1400}{1500} = 93.3 \quad [\%]$$

In both cases the parameter that must be modified are the following:

DA3 = 1K5	Current size of the converter.
DB3 = 1400	New full scale value of the current.
DB6 = 50%	Motor current in comparison with IaM . . $DB6 = 100 \cdot \frac{Ia_T}{Ia_M}$

Example 3: ☑ motor overload ☑ converter overload

The rated current Ia of the motor is Ia_T = 700 A and the application needs a duty cycle according the following diagram of figure C2.3 (5 second with a current overload of 150% and than 1minut with a current load of 300A).
The suitable SPDM for this application must be able to supply the maximum current requested by the duty cycle (IaM = 1050 A). According to the table of the chapter A3 we select the converter SPDM850 (rated current of the converter IN = 850A). The selection must verified according the overload curve of the converter (see chapter A8).

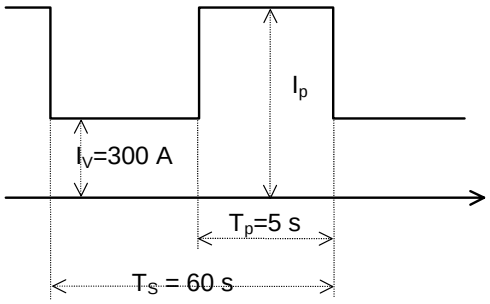
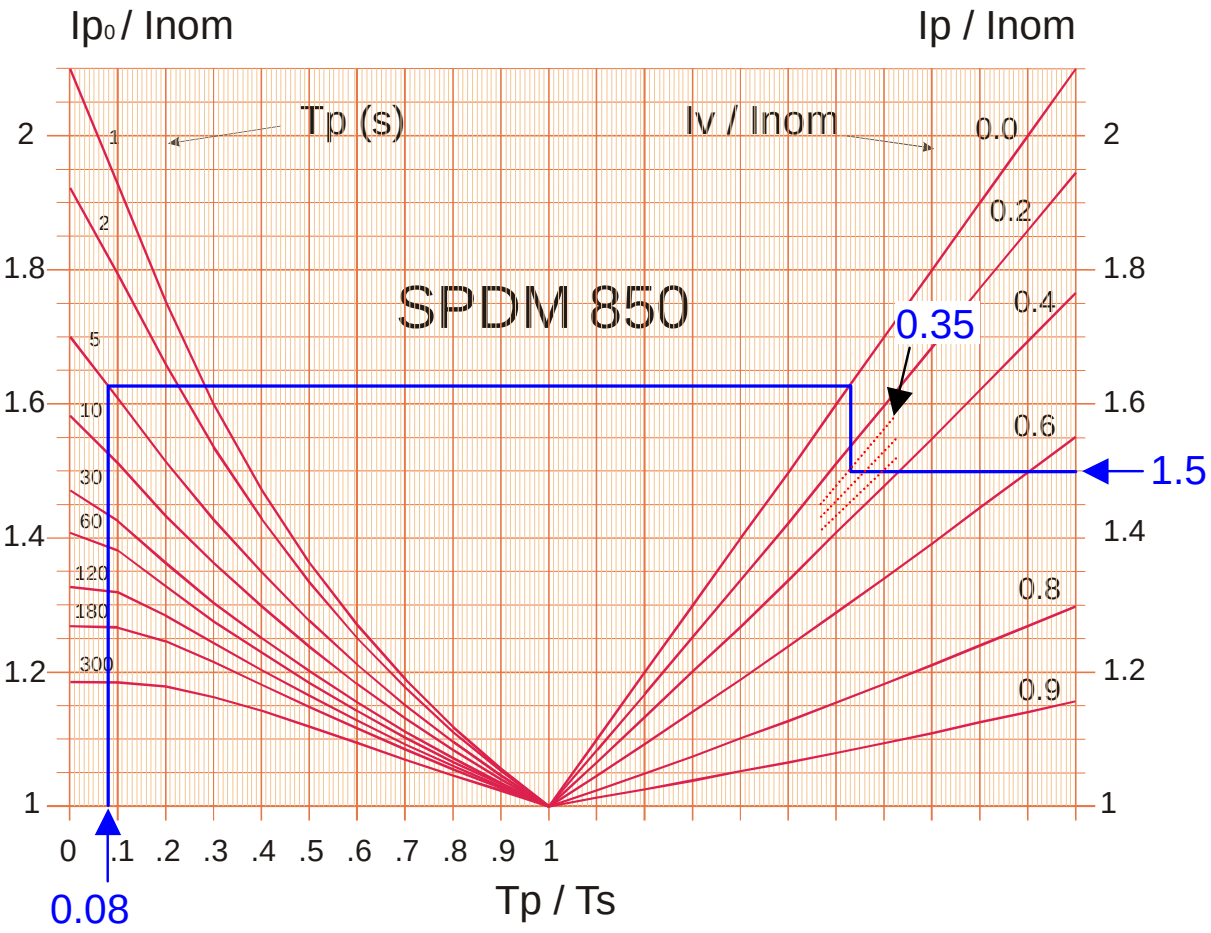


Figure C2.3: Duty cycle

Tp = 5 s Ts = 60 s Tp / Ts = 0.08
IaM = 1050 A IN = 850 A Iv = 300 A Iv / IN = 0.35



According to the overload diagram and to the duty cycle of figure C2.3, the converter SPDM850 can supply a maximum current Ip=1.45 * IN = 1.5 * 850 = 1275 A. This current value is greater than the maximum current of the duty cycle of figure C2.3 (1050 A) so the SPDM850 is right to the application.

First solution: Load resistors change. The table C2.3 shows the CT turns ratio Ns = 4000: by the formula (1) it is possible the calculate the load resistors value:

$$R_p = 2 \cdot \frac{N_s}{Ia_M} = \frac{8000}{1050} = 7.6 \quad [\Omega]$$

this ohmic value can be obtained by connecting in parallel one resistor $R_{X56 - X57}$ = 10 Ω with a second resistor $R_{X58 - X59}$ = 33 Ω.

Second solution: Parameter DJ8 change. Instead off changing the load resistors it is possible to adjust the parameter DJ8 according the formula (2):

$$DJ8 = 100 \cdot \frac{Ia_M}{Ia_N} = \frac{1050}{850} = 123.5 \quad [\%]$$

In both cases the parameter that must be modified are the following:

DA3 = 350 Current size of the converter.
DB3 = 300 New full scale value of the current.
DB6 = 100% Motor current in comparison with IaM .. $DB6 = 100 \cdot \frac{Ia_T}{Ia_M}$

C2.4 "C" Board customizing

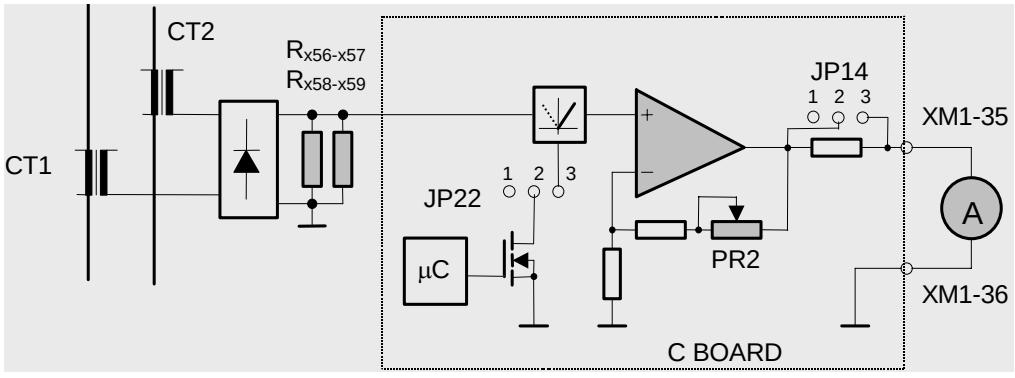
Before applying power to Silcopac D, verify the following connections (see par. C2.8):

JP1	open
JP2	open
JP3	jumper pins 1 - 2; the optional board SPDS, must be removed
JP4	jumper pins 1 - 2;
JP5	open
JP6	jumper as JP3;
JP7	jumper pins 2 - 3
JP8-9-10-11-12	if the speed feedback transducer is an encoder the position of these jumpers is unimportant; while if it is a tacho generator evaluate the max. tacho voltage value and insert the related jumper only, as described in par. C2.7.2, terminal XM1-26. Example: max.motor speed 1500 rpm; tacho voltage 60V at 1000 rpm; max. Tacho voltage $V_t = 60 \bullet \frac{1500}{1000} = 90V$; jumper to be inserted: JP8.
JP13	open
JP14	open. See Ia_monitor description, par. C2.4.1
JP15-16-17	insert jumper related to the armature external voltage transducer Va, as described in Manual IMSPD011A par. C2.7.3, terminal XM1-32.
JP18	open. See N_monitor description, par. C2.4.2
JP19	open
JP20	open
JP21	open
JP22	open
JP23	closed
JP25	jumper pins 2 - 3

C2.4.1 Ia – monitor

The armature current Ia can be indicated by a meter A connected to terminals XM1-35, 36; the meter is a.d.c. milliammeter 5 mA f.s. or a.d.c. voltmeter 10 V f.s.
If a milliammeter is used, jumper .
If a voltmeter is used, jumper JP14 must be closed.

If a milliammeter is used, (full scale 5mA)	JP14 must be closed on 1-2 position;
If a voltmeter is used, (full scale 10V)	JP14 must be closed on 2-3 position;
With 2 quadrant SPDM	the meter may be a lateral zero type (preferred) or centre zero type. Set JP22 on 1-2.
With 4 quadrant SPDM	the meter must be a centre zero type. Set JP22 on 2-3 Optionally, if the armature current direction doesn't care, it is possible to read the absolute value only; in this case the meter may be a lateral zero type; set JP22 on 1-2.



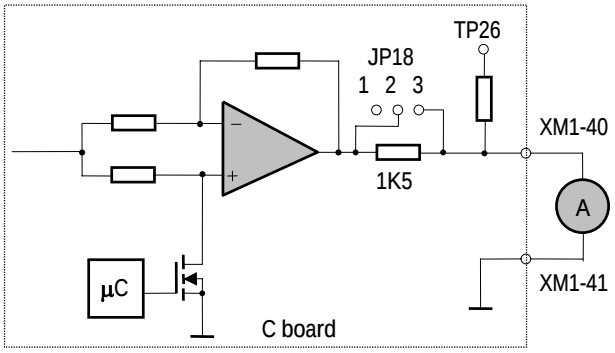
By trimmer PR2, adjust the full scale meter reading corresponding to the maximum current.
DJ8
The trimmer PR2 is located on the right corner of the control board (C).



C2.4.2 N - monitor

The motor speed can be read by a meter N connected to terminals XM1-40, 41 (programmable analog output PWM3); to enable this output as speed signal, set the parameter DM3 = N.

If a milliammeter is used, (full scale 5mA)	JP18 must be closed on 1-2 position
If a voltmeter is used, (full scale 10V)	JP18 must be closed on 2-3 position
With 2 quadrant SPDM	the meter may be a lateral zero type (preferred) or centre zero type. Set parameter DMC = ON.
With 4 quadrant SPDM	the meter must be a centre zero type. Set parameter DMC = OFF. Optionally, if the revolution direction doesn't care, it is possible to read the absolute value only; in this case the meter may be a lateral zero type; set parameter DMC = ON.



C2.5 Exciter customizing (SPAE1A)

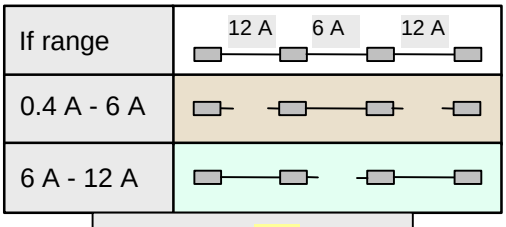
The internal exciter SPAE1 is mounted in the Silcopac D fixing it down at the drive top cover using an angle iron that is a part of the radiant heat surface. At the end of the mounting operations the board is in front view.

WARNING For the proper operations of the internal exciter SPAE1 the terminals U and W of the SPAE1 (terminal board XM4) and the terminals U and W of the P board (terminal board XM2) respectively must be in phase.

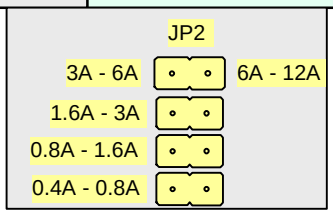
C2.5.1 Field current transducer configuration (SPAE1A)

The CT (CT1) primary circuit, mounted on the phase W of the exciter board, is made by two turns that can be connected in parallel or in series depending on the desired field current range.

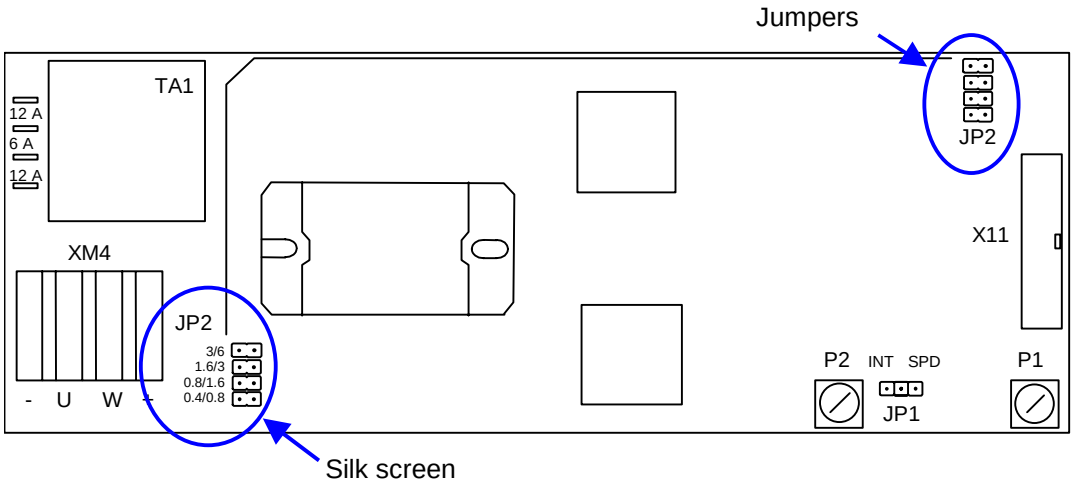
The customizing is made by closing jumpers, on the four turrets located near the CT, as shown by the following diagram:



To obtain the correct field current range it is necessary to customize the jumper JP2 configuration on the exciter SPAE1A as shown by the following diagram:



The silk-screen printing that shows the information to customize the jumper JP2 can be found at the left down side of the board near the XM4 terminal block.



C2.5.2 Configuration of the field current reference source (SPAE1A)

The jumper JP1 allows selecting two possible sources of the field current reference:	A	JP1 closed on INT : field current reference comes from P2 trimmer (on SPAE1 board)
	B	JP1 closed on SPD: field current reference comes from C board by means of X11 connection (see E.M.F. Regulator function paragraph C2.9.1)

The A configuration of jumper JP1 is used only with motors without field-weakening and when the field saving function isn't requested (see E.M.F. Regulator function paragraph C2.9.1).

The flat cable connection between the X1 connector on board P and the X11 connector of the exciter allows the delivery of the current reference and the acquisition of the current feedback (see If_F protection at par. 1.2.1) from board C through board P to the exciter.

C2.6 Setting parameters

After the customization of C, P and SPAE1 board it is necessary to set same parameters regarding the specifications of the motor, the converter and the plant.
Apply power to the control circuits only, terminal block XM2 on board P; the micro controller begins the Power-up sequence described at par. C1.3.1 STATUS; at the end, the user can set the proper parameters.

using the pushbuttons U - D select on the display of SPDI 1 user interface the function:	CONF. PARAMETERS	if the parameter code (e.g. CA1) begins with C; select the parameter and assign the value as described at par. C1.3.2;
	TUN. PARAMETERS	if the parameter code (e.g. TB2) begins with T; select the parameter and assign the value as described at par. C1.3.3;
	DRV. PARAMETERS	if the parameter code (e.g. DC3) begins with D; select the parameter and assign the value as described at par. C1.3.4.

The applicable parameters are the following (see basic reference diagram, par. A7.6 and simplified block diagram, par. C3,);

Plants

BLOCK	PAR.	DESCRIPTION
21 supply line	DB1	line voltage available at terminals AK1, AK3, AK5
22 SILCOPAC D	DA1	Silcopac D serial number
Silcopac D serial number	DA2	Two quadrant or four quadrant converter
	DA3	Silcopac D current size
24 motor	DB3	motor max operating current, par. C2.3
	DB4	armature nominal voltage
	DB5	max motor operating speed
	DB6	motor nominal current
	DB7	motor base speed (only for weakened field operation)
	DB9	RI drop across the motor at Ia_M current (only with the manual adjustment of the current loop)
25 field	DB2	motor field nominal current
26 encoder	DB8	encoder pulse / rev ratio (if used)

Converter

BLOCK	PAR.	DESCRIPTION
1 speed reference	CB1	select CB1 = RIF
4 ramp	TE1	acceleration time from zero to max speed; assign TE1 = 2
	TE2	deceleration time from max to zero speed; assign TE2 = 2
5 speed feedback	CB3	select CB3 = Encod if an encoder is used (default) select CB3 = Tach if a tacho generator is used
14 E.M.F reference	CC1	field current reference (percentage) for the field saving function
	DB7	base speed
16 E.M.F regulator	CCA	select ON; E.M.F. regulator enabled
31 micro controller	CDA	EEPROM write enabled. The writing is enabled by default (CDA = ON); at the end of the parameters setting and the regulators adjustment, disable the writing function selecting CDA = OFF

NOTE

it is possible to reset all parameters with the default value using the following procedure :

- close Jumper JP19
- set parameter CDF ON
- reset the control
- the control goes to TEST EEPROM FAILED status (r-5); when the 7 segment led on board side goes off and terminal SPDI1/SPDI2 goes on, reset the control; the control goes to TEST ENTER PAR. DA1 status;
- actually the DA1 parameter has the value Ø by default; set with the series number on the label; reset the control.
- the control is now ready to be reset; insert the parameters related to factory pre-calibrations as shown in the parameter printouts enclosed with the control. (the parameters bearing an asterisk - * - have a different value than the default ones).

C2.7 Field current adjustment

The first step of the set-up procedure is the tuning of the transducers that are the measurement instruments, used by the converter, by means of which the electrical variables to be controlled can be read.

Only the proper adjustment of the mains voltage, of the armature voltage and of the tacho-generator (if used) transducers assures the best performance of the SPDM .

Before beginning the adjustments verify that the parameter CD2 is on %.

The reading of variables as the field current feedback, the armature voltage, the speed feedback and the reading of the signals for the reference (speed, current, etc.) are made by means of the analog inputs (terminal XM1 - 26, 28, 29, 30, 32, 33, 34, see jumper JP25 too).

C2.7.1 Offset self-tuning

To acquire an accurate reading of the signals applied to the analog inputs, the offset null on the acquisition circuits is needed.

It is possible to manually carry out the offset tuning:	- disconnected the terminals of the analog inputs
	- open jumper JP25
	- set parameters DCF = OFF and DCO = OFF
	- set to 0 the parameters from DH1 to DH6
	- open the main contactor
	- open the main contactor
	- through the Hardware Status function- Analog Input (par. C1.3.6) read the signal on the analog input: Tach, If, Ean1, Ean2, Ud and No
	- set parameters DH1 to DH6 to the negate of the read value (ratio value);
or using the Offset Self tuning automatic procedure:	- disconnect the terminals of the analog inputs
	- open jumper JP25
	- select the Offset Self tuning function (par. C1.3.10)
	- open the main contactor
	- enable the Start command (terminal XM1-13)
	- at the procedure end, disable the Start command

C2.7.2 Personalisation of the mains voltage transducer

1) Set the parameter DB1 at the value of the rated voltage applied to the power input of the SPDM (for example 400V).
2) Gauge with a voltmeter the voltage applied to the power input of the SPDM. (we call U_{ON} this value).
3) Read on the INSTRUMENT MODE (paragraph C1.3.5) the ratio value of the mains voltage. (we call Uvo[%] this value).
4) Read on the DRIVE PARAMETERS group (paragraph C1.3.4) the current value of the parameter DJ7 (we call DJ7current this value).
5) The new value of the parameter DJ7 shall be calculated according the following formula

DJ7new=DJ7current * (UON / DB1) * 100 / Uvo[%]

C2.7.3 Personalisation of the armature voltage transducer

The rough personalization of the transducer is made by means of three jumpers: JP15, JP16 and JP17.

Close just one of the three jumpers according to the applied armature voltage and the voltage version of the converter (G, H, K, W, M, N).

Voltage version	Jumper	Armature voltage		KKU
		from	to	
G	JP15	160V	300V	30075
	JP16	300V	570V	56980
	JP17	570V	900V	88889
H – K - W	JP15	200V	380V	38045
	JP16	380V	720V	72080
	JP17	720V	1100V	112444
M – N	JP15	240V	450V	45564
	JP16	450V	860V	86325
	JP17	860V	1300V	134667

The precision calibration is made through the parameter DJ5 (gain on the analog input Ud).

Apply the following formula to calculate the value of DJ5:

$$DJ5 = \frac{KKU}{\text{Armature voltage in Volt}}$$

The adjustment of the armature voltage transducer must be verified as explained on the paragraph C2.9.

C2.7.4 Preliminary adjustment of the tacho-generator transducer

The rough personalization of the transducer is made by means of 5 jumpers: JP8, JP9, JP10, JP11 and JP12.
One jumper only or no jumpers must be closed according to the max voltage delivered by the tacho-generator (voltage at motor highest speed).

JUMPER	Tacho generator voltage		KKT
	from	to	
JP12	0V	10V	1000
JP11	11V	19V	2000
JP10	20V	36V	3801
JP9	37V	69V	7106
JP8	70V	131V	13907
----	132V	250V	25100

The accurate calibration is made through the parameter DJ1 (gain on the analog input Tach). Apply the following formula to calculate the value of DJ1:

$$DJ1 = \frac{KKT}{\text{Tacho gen. voltage with } N = NMax}$$

KKT is a constant depending on the selected jumper, as shown in table:

C2.8 Field current adjustment

C2.8.1 Inside exciter SPAE1

1) Verify the customizing of the exciter board (par. C2.5.1 and C2.5.2).
2) Connect an ammeter in series to the field (terminal block XM4).
3) Set parameter DK2 = 20 and parameter CCA = OFF.
4) Close the Jumper JP1 of the SPAE1 on INT (constant field current).
5) Close the Jumper JP25 of the C board on pins 2-3.
6) Rotate the trimmer P2 fully counter-clockwise to zero the field current reference
7) Power up the SPDM and the exciter and disable the protections DCF and DCN (DRIVE PARAMETERS, group C - PROTECTIONS).
8) Rotate the trimmer P2 clockwise until the ammeter shows the desired field current.
9) Through the Hardware Status function (par. C1.3.6) read the If value (ratio value) at the ANALOG INPUT; rotate the trimmer P1 until you read the correct value (If) at +100%.

If the motor must operates in field-weakening range, or you want to enable field save function, or you want to set to zero field current if any protection occurs it is necessary to continue with the following points; on the contrary go on to point 15 (CCA=ON).

10) Move the JP1 of the SPAE1 on SPD.
11) Check that the parameter DM2 is programmed as If_0.
12) Read on the ammeter the field current (amps).
13) Set the parameter DM8 according the formula: $DM8 = DM8_P \cdot \frac{If_M}{If_A}$

where: If_A = field current red by the ammeter.
If_M = rated field current of the motor.
$DM8_P$ = previous value of the parameter DM8. DM8 value must be negative.

14) Through the Hardware Status function- (par. C1.3.6) read on the Analog Input item the If value (in %); rotate the trimmer P1 until to read a field current (If) equal to +100%.
15) Power off the SPDM and the SPAE1 and restore the field circuit removing the ammeter and enabling the protections.

C2.8.2 Outside exciter

If the external exciter (SPAM, SPATE or SPDME) is controlled by the SPDM it is necessary:

1. to verify that the parameter DM2 is programmed as If_0.
2. to set parameter DK2 = 20 and parameter CCA = ON.
3. to close the Jumper JP25 of the C board on pins 1-2.
4. to do the connection with shielded cable according the figures C3.7.1, C3.7.2 e C3.7.3.

- The output PWM2 (XM1-39) must be connected to reference input of the exciter.
- The input IF (XM1-28) must be connected to the output of the exciter where is available a voltage signal proportional to the field current.
- Connect the 0V of the SPDM control circuit to the 0V of the exciter.
- The shield must be connected to 0V of the exciter only.

5. Power up the SPDM and the exciter and disable the protections DCF and DCN (DRIVE PARAMETERS, group C - PROTECTIONS).
6. Read on the ammeter the field current (amps).
7. Set the parameter DM8 according the formula: $DM8 = DM8_P \cdot \frac{I f_M}{I f_A}$

   where: If_A = field current red by the ammeter.
   If_M = rated field current of the motor.
   $DM8_P$ = previous value of the parameter DM8. DM8 value must be negative.

   For SPAM and SPATE exciters, DM8 value must be negative.
8. Through the Hardware Status function (par. C1.3.6) read the If value (ratio value) at the ANALOG INPUT; adjust the parameter DJ2 until you read the correct value (If) at +100%.
9. Power off the SPDM and the SPAE1 and restore the field circuit removing the ammeter and enabling the protections.

Le figura seguenti mostrano i collegamenti con SPAM, SPDME e SPATE.

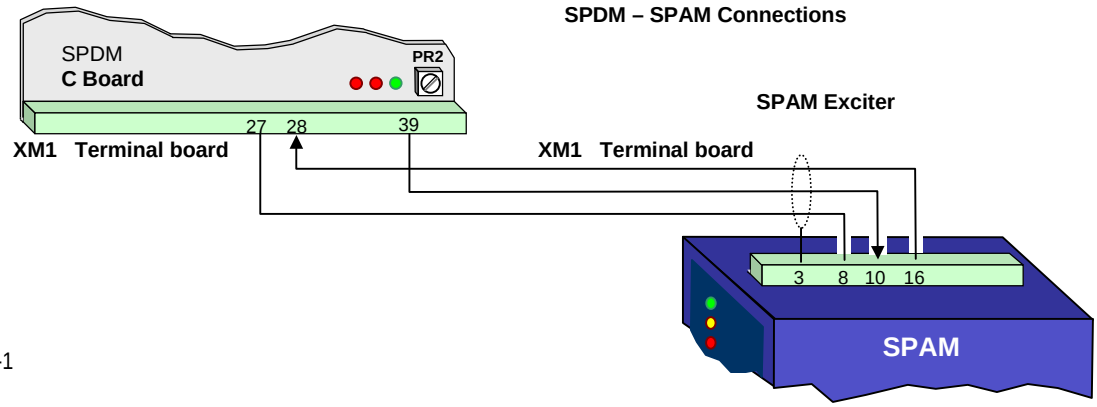


Figure C3.7-1

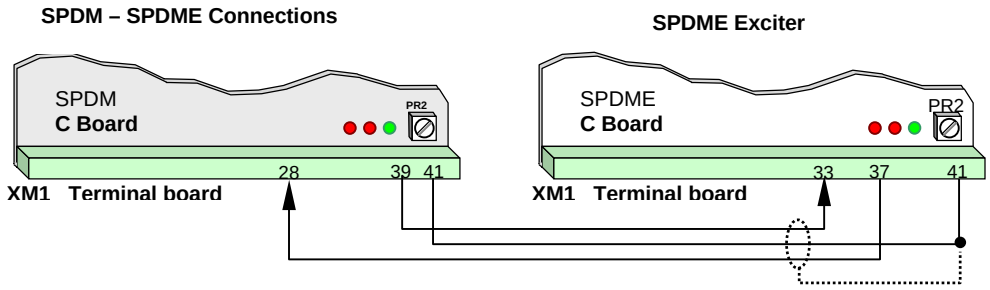


Figure C3.7-2

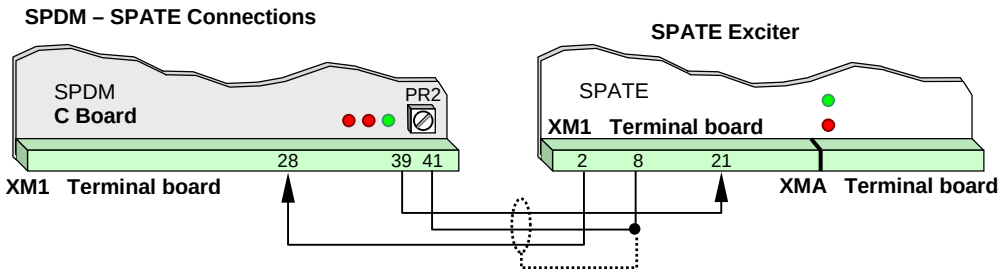


Figure C3.7-3

NOTA

If there is a main contactor on the input terminals of the exciter it is necessary:
set the parameter "CCC"=ON
connect a normally open contact (NO) of the contactor to the SPDM terminals XM1-20 e XM1-23

C2.6.3 Verifying the proper setting of the voltage transducer

It is necessary to regulate in angle the forward bridge thyristors, paying a particular attention since, in this mode of operation, current and speed regulators are removed.

Act as follows:

1. With START command disabled (terminal XM1-13), supply control, exciter and power; the led on the panel will display the suppression status (H - 1 flashing).
2. Select the “INSTRUMENT MODE” function, then select Ud (armature voltage) and N (speed signal).
3. Select the “SETUP REFERENCE” function and then select “ANGLE REF. FRW.”, press <*enter*>»; an angle of 165 degrees will be displayed, decrease this angle to 105 degrees (do not press <*enter*>»).
4. Connect a dc voltmeter to SPDM terminals KM and AM
5. Enable the START command; the led on the panel will display the regulation status with zero speed O (or not flashing). Press <*enter*>; the display will automatically show Ud and N.

   If the motor works at a speed higher than 2% of the nominal speed, the indication of the led on the panel will change from O to F forward rotation) or from O to I (reverse rotation).
6. Verify the wanted direction of rotation and check Ud and N polarities, which, since the forward bridge is enabled, must be positive.

   Should the N value be negative, invert tacho-generator polarities and go back to point 3
7. Decrease the starting angle by steps no greater than 5 degrees until to read on the voltmeter a value equal to half armature rated voltage Ud = 50 %.
8. Set DJ5 as follows: $$DJ5 = DJ5c \cdot \frac{50}{Ud_L[\%]}$$
   a. DJ5C = value of the currently set up parameter
   b. UdL[%] = value of armature voltage in % shown on the display
9. Connect the voltmeter to the ends of the tacho-generator and verify that the voltage displayed corresponds (depending on its V/RPM characteristic) to the speed shown on the display.
10. Should it be not corresponding, act on the angle reference until the voltmeter reading gives a voltage that is 50 % of the tacho-generator voltage at the motor rated speed and then set DJ1 as follows: $DJ1 = DJ1c \cdot \frac{50}{N_L[\%]}$
    a. DJ1c = value of the currently set up parameter
    b. NL[%] = value in % shown on the display
11. Once you have completed these operations, increase the angle until the limit value of 165 degrees and press <*enter*>» to switch off the motor.
12. When the motor has stopped, disable the START command.

NOTE: angle 0 ° = natural starting moment.

C2.6.4 E.M.F. Regulator

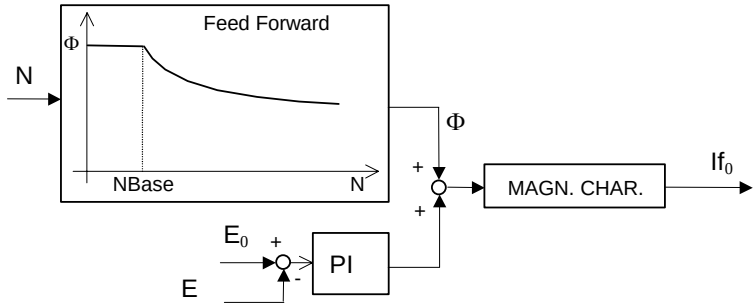
The E.M.F. regulator must be enabled in all applications where field weakening motor is used, where the field saving function is required and where winder functions are used (paragraph E8 configurations 3 and 4).
The E.M.F. regulation needs a controlled exciter (see paragraph C2.8):

With inside exciter (SPAE1) — the control signals are exchanged by the flat-cable that connects the connector K1 of the SPAE1 to the connector X11 of the P board (jumper JP25 of the C board closed on pins 2 – 3).

With outside exciter — The field current reference is available on the terminals XM1-39, 41 of the C board (analog output Pwm2), the field current feedback is acquired by the terminals XM1-28, 31 (analog input If) (jumper JP25 of the C board closed on pins 1 – 2).

The regulator enable occurs by setting the CCA parameter to ON.

The regulation is handled by two blocks: Feed-Forward regulator and proportional/integral regulator; the sum of the two regulator blocks output is transformed by the magnetization characteristic to generate the field current reference.



The Feed-Forward regulator evaluates the flux value as function of the present speed if higher than the base speed; the proper setting of DB7 parameter is then mandatory. The regulation is of the predictive type which allows high level performances.

The PI regulator corrects the little errors introduced during the magnetization characteristic detection phase. The E.M.F. Self tuning function allows the magnetization characteristic detection with very high precision, avoiding the need to set the TG1 and TG2 parameters to other than the default values.

If the Ud_F protection occurs (par. C1.3.11) the E.M.F. regulator zeroes the field current reference. When the CCC parameter is set to ON, every time the system goes in the PROTECTION status the field current reference (Ifo) is set to zero.
It is possible to display the E.M.F. value by setting one of the parameters DG5, DG6 and DG7 to the EMF value.

C2.9.2 Field saving

The field saving function occurs after the zero speed signal (see parameters CB5 and CB6) if the converter status is different than the regulation. The intervention time of the field saving function, expressed in millisecond, is established by the CC3 parameter, with the following formula:

$$T = CC3 \bullet CD3$$ where the value CD3 can be 3.3, 5 or 10 ms.

The field current reference takes the value set on the CC1 parameter.
The function is enabled only if JP1 (SPAE1) is closed on 'SPD' or, in the case of external exciter, if the current reference on C board is used (see paragraph C2.8)..

C2.9.3 Speed feedback from armature voltage

When the speed feedback is the armature voltage (CB3 parameter = F (Ud)), the motor field current value is represented by the CC4 parameter.
In case of non field weakening motors, the CC4 shall remain unchanged at 100% (default value); in case of field weakening motors, the CC4 can be reduced in order to reach speeds higher than the base value (DB7 value).

The maximum achieving speed is represented by the formula: $NMax = \frac{DB7}{CC4} \bullet DB5$ [rpm]

The CC4 parameter can't assume percentage values lower than DB7: the setting of the parameter CC4 at value lower than DB7 will be ignored and signalled through the message CONSISTENCY ERROR.

C2.10 Regulator adjustment

The current, speed and E.M.F. regulators adjustment are automatically or manually executed.
The automatic adjustment is made through the SELFTUNING function, par. C1.3.10: the converter performs automatically some operating cycles, during which the micro controller executes the needed measurements and assigns the proper value to the related parameters.
The manual adjustment is made by the help of the SET UP REFERENCE function, par. C1.3.7.

The adjustment will be accurate only if it is executed in the following order:

1st armature current loop
2nd motor speed loop
3rd motor E.M.F. loop

C2.10.1 Current loop automatic calibration

- Set DJ8 to 100 % (change CT load resistors on P board, if necessary - see paragraph C2.3).);
- Check that the current limits TA3 e TA4 are respectively +100% and –100%.
- Power off the exciter;
- Disable the field loss protection DCF = OFF;
- With the START command enabled, supply power and control;
- Select the “SELFTUNING” function, then select “CURRENT SELFTUNING” and press <enter>;
- Enable the START command and wait for the calibration execution following the instructions shown on the display.

If the CURRENT SELFTUNING fails check if the motor runs throughout the calibration execution,

C2.10.2 Speed loop automatic calibration

The speed loop automatic calibration must be done with the load applied to the motor

- Enable the field lack protection DCF = ON ;
- Supply the exciter;
- Disable the field loss protection;
- With the START command enabled, supply control and power;
- Select the “SELFTUNING” function, then select “SPEED SELFTUNING” and press <enter> ;
- Enable the START command and wait for the calibration execution following the instructions shown on the display.

WARNING

During the speed loop automatic calibration the motors accelerates from zero speed till to base speed with rated torque. In same application this cannot be allowed by the load so it is better the speed loop manual calibration See paragraph C2.17 the additional instructions for the use of the speed Self tuning function.

C2.10.3 E.M. F. loop automatic calibration

Before to do the E.M. F. loop automatic calibration it is necessary the calibration of the voltage transducer according the instruction of the paragraph C2.7.2, C2.7.3 e C2.9.

The E.M. F. loop automatic calibration detects the magnetization characteristic of the motor so can be done with the field weakening motors only (constant power).

- With the START command disabled, supply control, power and the exciter;
- Select the “SELFTUNING” function, then select “EMF SELFTUNING” and press <enter>;
- Enable the START command and wait for the calibration execution following the instructions shown on the display. During the procedure the motor runs at base speed (appointed by parameters DB5 and DB7).

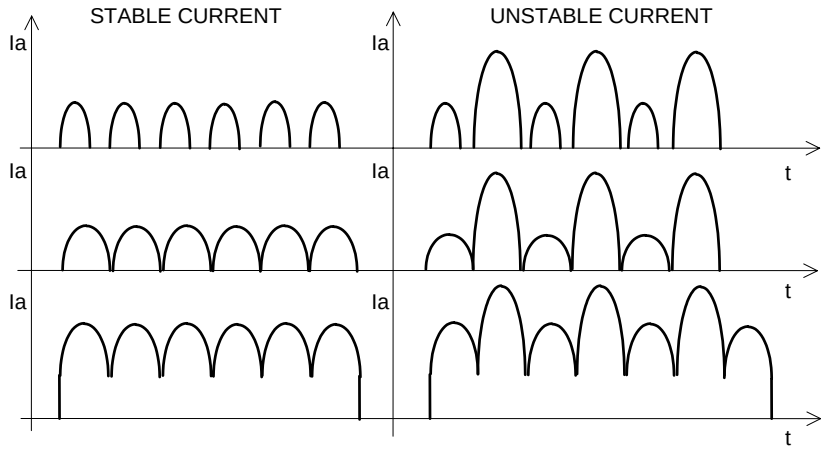
C2.10.4 Adjustment check

The adjustment check of the regulation loops consists of two steps:
the first step is static stability verification;
the second step is system step-response verification.
The two check steps must be executed according to the following sequence.
An oscilloscope is needed to display the typical waveforms.

CURRENT LOOP - Static stability verification.

- Open the motor field, disable the If_F protection (parameter DCF = OFF) and the stall protection (parameter DCN = OFF); if needed, mechanically lock the motor rotor.
- Connect the scope to tests points TP17 (signal) and TP8 (ground) of board C (par. C2.15); set the scope time base to 5 ms/div and the vertical scale factor to 500 mV/div.
- Through the SETUP REFERENCE function (par. C1.3.7), set a current reference (FIXED) starting from a value equal to 10% and, step by step, increase the value up to 100%.

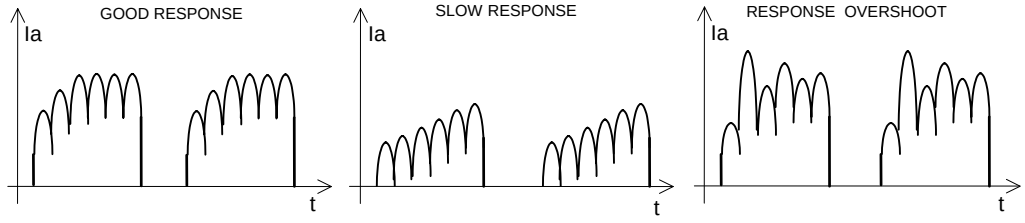
At each step verify the waveform displayed on the scope as shown in the following figure:



CURRENT LOOP - Step response verification.

It is recommended to avoid this test if the static stability verification shows some critical areas.

According to the same conditions of the previous verification, set the parameter DG8 = 100% and the parameter DG9 = 0.1s; through the SETUP REFERENCE function (par. C1.3.7), set a square wave current reference (SQUARE) with center value equal to 0%. The waveform, displayed on the scope, must be as shown in the following figure:



Restore the motor field circuit, re-enable the If_F (parameter CDF = ON) and stale (parameter DCN = ON) protections.

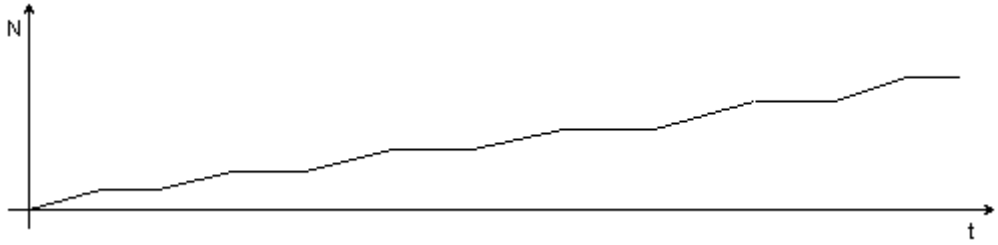
SPEED LOOP - Static stability verification.

To display the speed signal it is required that one of the analog outputs, terminals XM1 - 37, 38, XM1 - 39, 41, XM1 - 40, 41 (par. C7.1.1) be programmed as N (DM1, DM2, DM3 parameter).

Connect the scope to test points TP24, TP25 or TP26 (par. C3.9) depending on the analog output programmed as N (signal) and to test point TP8 (ground) of board C.

Set the scope time base to a value higher than 1s/div and the vertical scale factor to 1 V/div or 2 V/div.

Through the SETUP REFERENCE function (par. C1.3.7), set a continuous speed reference (CONT. SPEED REF.); at each speed change of about 5%, verify that the waveform is like the following figure:



The stability over the whole range from 0 to 100% and under load conditions has to be verified.

SPEED LOOP - Step response verification.

It is recommended to avoid this test if the static stability verification shows some critical areas.

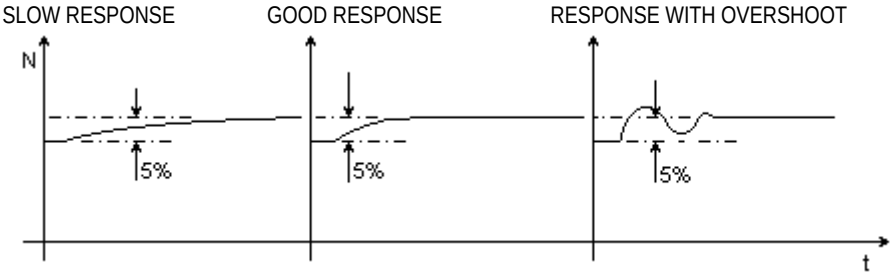
To display the speed signal it is required that one of the analog outputs, terminals XM1 - 37, 38, XM1 - 39, 41, XM1 - 40, 41 (par. C7.1.1) be programmed as N (DM1, DM2 , DM3 parameters).

Connect the scope to test points TP24, TP25 or TP26 (par. C3.9) depending on the analog output programmed as N (signal) and to test point TP8 (ground) of board C.

Set the scope time base to a value higher than 1s/div and the vertical scale factor to 1 V/div or 2 V/div.

Through the SETUP REFERENCE function (par. C1.3.7), set a speed reference step applied (SPEED REFERENCE), starting from a value equal to about 5% and, by 5% steps, increase the value up to 100%.

At each step verify the waveform displayed on the scope as shown in the following figure:



C2.10.5 Manual adjustment

CURRENT LOOP

Set TA1, TA2 and DB9 parameters according to the following formulas:

$$TA1 = \frac{145 \cdot T \cdot E \cdot Vr}{DB6 \cdot Ta \cdot Vn \cdot Veff} \qquad TA2 = \frac{96 \cdot Ta}{T} \qquad DB9 = \frac{100 \cdot Vr}{DB6 \cdot Vn}$$

where:

T = supply line period in seconds (T = 0.02 for supply line frequency = 50 Hz).

Vn = motor armature rated voltage.

Vr = RI drop across the motor (Volts): it is the voltage at the motor terminals when the nominal current flows in the motor itself and the rotor is locked.

E = Vn - Vr.

Ta = armature time constant (seconds): the typical value is in the range 0.005s to 0.04s.

Veff = bridge supply RMS voltage (typical value: 400V).

CURRENT LOOP - Step response verification.

Verify the static stability verification of the current loop, if this test shows:

♦ some unstable areas	decrease the value of TA1 and TA2 parameters; repeat the procedure until a stable response will be achieved on the whole range 0 to 100%.
♦ a slow response	increase the TA1 parameter value and/or decrease the TA2 parameter value
♦ an overshoot response	increase the TA2 parameter value and/or decrease the TA1 parameter value; repeat the procedure until a good and sufficiently fast response will be achieved.

SPEED LOOP

Set TC1, TC2 and CA4 parameters according to the following formulas:

$$TC1 = \frac{\varpi v \cdot Tacc \cdot 64 \cdot DB5}{Ir \cdot NBase} \qquad TC2 = \frac{\varpi v \cdot TC1}{10} \qquad CA4 = \varpi v \cdot 5$$

where:

ω_V = speed regulator bandwidth in rad/sec (typical value 5 rad/sec <= ϖ_V <= 10 rad/sec).

Tacc = acceleration time (seconds) needed by the system to increase the speed from 0 to the base speed, with the armature current equal to Ia_N (par. 2.3). The acceleration time must be measured with load connected.

Ir = ratio between the motor max operating current Ia_M and the motor operating current Ia_N (par. 2.3).

NBase = motor base speed in rpm.

SPEED LOOP - Step response verification.

Verify the static stability of the speed loop and if this test shows:

♦ some unstable areas	decrease the value of TC1 and TC2 parameters; repeat the procedure until a stable response will be achieved over the whole range 0 to 100%.
♦ a slow response	increase the TC1 and/or TC2 parameter value
♦ an overshoot response	decrease the TC1 and/or TC2 parameter value; repeat the procedure until a good and sufficiently fast response is achieved.

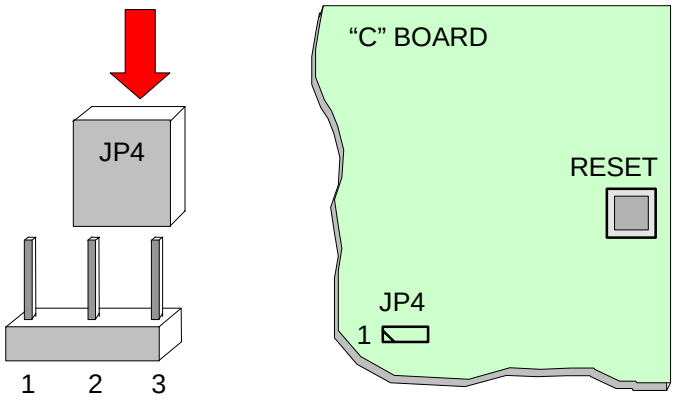
C2.11 Parameters block

Once the set up has been completed, in order to prevent parameters from being casually or intentionally changed or from being lost owing to interferences, it is necessary to block the EEPROM writing (programmable memory in which parameters values are stored).
Proceed in the following manner:

(a) supply the converter control on terminals XM2 U - V - W

(b) make sure the converter is not in protection;

(1) through the <*mode*> key on the panel disable the STATUS function;
through the Δ ∇ keys select the CONF.PARAMETER item;
press <*enter*> and insert the password by using the keys Δ ∇, press <*enter*> to confirm;
through the Δ ∇ keys select the group D - MISCELLANEA and press <*enter*> to confirm;
through the Δ ∇ keys select the CDA parameter and press <*enter*>;
through the Δ ∇ keys set the CDA = OFF parameter and press <*enter*> to confirm;
press <*mode*> twice to leave the function group.
(2) Disconnect the converter supply;
(3) Set the jumper JP4 on the 2-3 position



To enable the writing of parameters on EEPROM follow the steps above in the opposite sequence.

N.B. If you use the motopotentiometer with storage of the last set value (CBE = ON), then JP4 must be left on position 1-2.

C2.12 Reset of the converter

There are three possible way to reset the occurred protections:

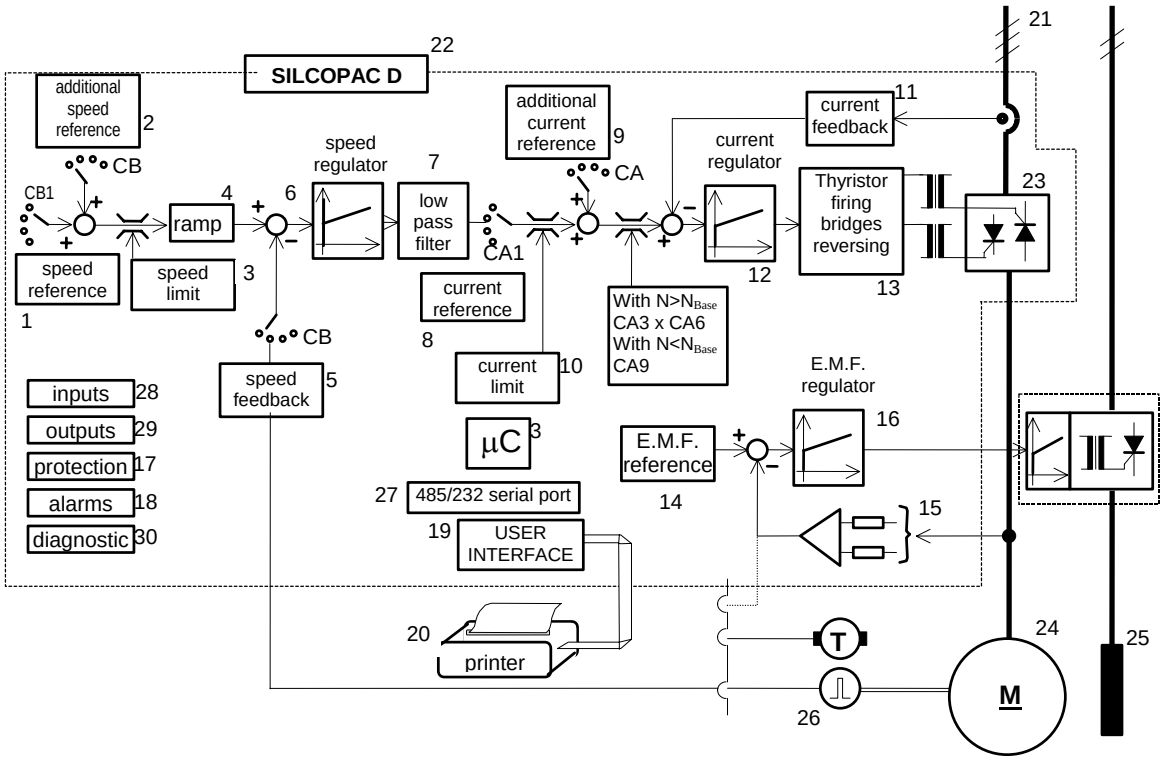
1 – to press the button RESET showed in the figure above
2 – to power on the terminal XM1-21with external 24V
3 – to keep pressed simultaneously for three seconds the keys Up (Δ), Down (∇) and MODE

The reset acts if the converter is in PROTECTION status (P flashing on the display) or in TEST status only

( flashing)

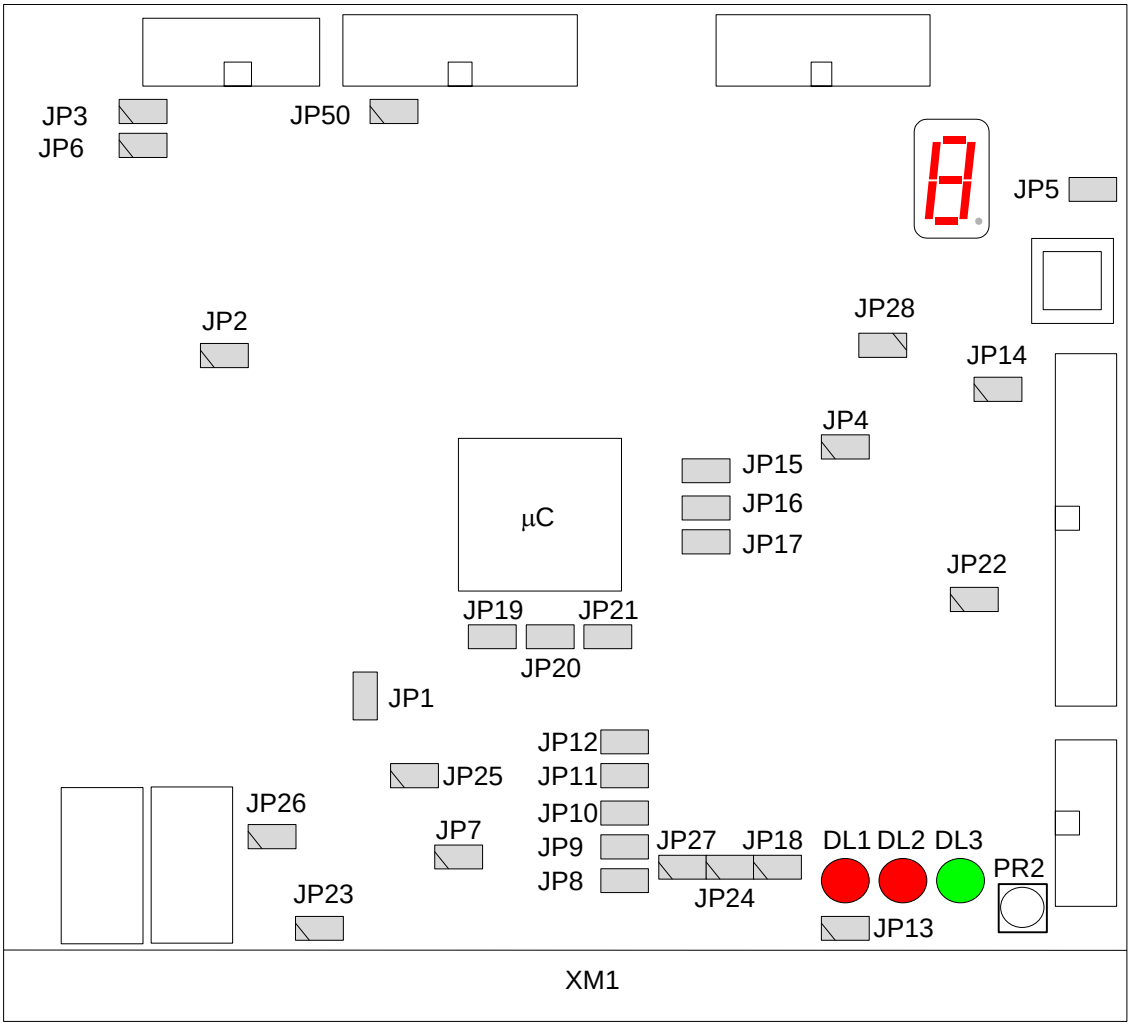
C2.7 Block diagram

This diagram shows the blocks included in the converter and the main configuration parameters CA1, CA3, CB1, CB2, CB3.



Legenda		
BLOCKS		PARAMETERS
1	speed reference	CB1 CB4 CB9 TC7 TC8 TD7 TD8
2	additional speed ref.	CB2 TC6 TD6
3	speed limitation	TC4 TC5 TD4 TD5
4	ramp	TE1 TE2 TE3 TF1 TF2
5	speed feedback	CB3 CBB CB5 CB6 CB7 CB8 CD5
6	speed regulator	CBA CBC TC1 TC2 TC3 TD1 TD2 TD3 TC9 TD9
7	low pass filter	CA4
8	current reference	CA1
9	additional current ref.	CA3 TA5 TB5
10	current limitation	CA2 CA5 CA6 CA9 TA3 TA4 TB3 TB4
11	current feedback	DJ8
12	current regulator	TA1 TA2 TB1 TB2
13	ignition / reversing	CA7 CA8
14	E.M.F. reference	CC1 DB7 DB9
15	voltage feedback	
16	E.M.F. regulator	CCA TG1 TG2
17	protections	DCA DCB DCC DCD DCE DCF DCG DCH DCI DCJ DCK DCL DCM DCN DCO DC1 DC2 DC3 DC4 DC5 DC6 DC7 DC8
18	alarms	DDA DDB DDC DDD
19	user interface	CD2
21	supply line	DB1
22	SILCOPAC D	DA1 DE2
23	converter bridge	DA2 DA3 DB3
24	motor	DB4 DB5 DB6 DB7 DB9
25	field	DB2 DP1 DP2 DP3 DP4 DP5 DP6
26	encoder	DB8
27	serial port	DEA DEB DEC DED DEE DEF DEG DE1 DE2 DE3 DFA DFB DFC DFD DFE DFF DFG DFH DFI DFJ DFK DFL DFM DFN DFO DFP DFa DFb DFc DFd DFe DFf DFg DFh DFi DFj DFk DFl DFm DFn DFo DFp
28	inputs	DH1 DH2 DH3 DH4 DH5 DH6 DJ1 DJ2 DJ3 DJ4 DJ5 DJ6 DJ7 DJ8 DK1 DK2 DK3 DK4 DK5 DK6 DLA DLB DLC DLD DLE DNA DNB DNC DND DNE DNF DNG DN1 DN2 DN3 DN4 DN5 DN6 DN7
29	outputs	DMA DMB DMC DM1 DM2 DM3 DM4 DM5 DM6 DM7 DM8 DM9 DOA DOB DOC DOD DOE DOF DO1 DO2 DO3 DO4 DO5 DO6
30	diagnostics	DGA DGB DG1 DG2 DG3 DG4 DG5 DG6 DG7
31	micro controller	CDA CD3

C2.14 Location of C board jumpers



DL1 = RED = "ON": WHEN THE MOTOR IS RUNNING
DL2 = RED = "ON": WHEN THE CONVERTER IS READY
DL3 = GREEN = "ON": WHEN THE BORADS ARE SUPPLIED

JP1	(reserved)	Open
JP2	(reserved)	Open
JP3		Inserted on the pins 1-2 to enable the serial communication RS232; the optional card SPDS, when it is present, must be removed. Inserted on the pins 2-3 to enable the serial communication RS485; the optional card SPDS, when it is not present, must be installed.
JP4		Inserted on the pins 1-2 to allow the writing on EEPROM memory. Inserted on the pins 2-3 to prevent the writing on EEPROM memory.
JP5	(reserved)	Open.
JP6		Like JP3.
JP7		Inserted on the pins 2-3 if the armature voltage transducer is used inside Silcopac D. Inserted on the pins 1-2 if an external voltage transducer is used. The transducer must be connected to the terminal XM1-32 (0 ÷ 10V).

JP8-9-10-11-12 Gauging of the tacho generator voltage. Insert only the jumper corresponding to the max value of the tachometric voltage, or no jumpers for the highest voltage interval.

JP12	0	÷ 10V
JP11	11	÷ 19V
JP10	20	÷ 36V
JP9	37	÷ 69V
JP8	70	÷ 131V
- - -	132	÷ 250V

JP13 Closed on the pins 2-3 if the access signal to the terminals XM1-33, 34 has a current of 0-20mA.
Closed on the pins 1-2 if the access signal to the terminals XM1-33, 34 has a voltage of ±10V.

JP14 Personalization of the output Ia_monitor, terminal XM1-35.
Closed on the pins 1-2 if the measure of the armature current has been taken when the current is on, through a milliamperemeter 5mA f.s. connected to the terminals XM1-35, 36.
Closed on the pins 2-3 if the measure has been taken live. See jumper JP22 too.

JP15-16-17 Gauging of the armature voltage transducer. Insert only the jumper corresponding to the nominal value of the armature voltage. Meaningless if the jumper JP7 is closed on the pins 1-2.

Voltage version	Jumper	Armature voltage from	Armature voltage to
G	JP15	160V	300V
	JP16	300V	570V
	JP17	570V	900V
H – K - W	JP15	200V	380V
	JP16	380V	720V
	JP17	720V	1100V
M – N	JP15	240V	450V
	JP16	450V	860V
	JP17	860V	1300V

JP18 Personalization of the output N_monitor, terminal XM1-40.
Closed on the pins 1-2 if the measure of the motor speed has been taken when the current is on, through a milliamperemeter 5mA f.s. connected to the terminals XM1-40, 41.
Closed on the pins 2-3 if the measure has been taken live.

JP19 EEPROM programming at Default values (see parameter CDF)

JP20 (reserved) Open.

JP21 (reserved) Open.

JP22 Closed on the pins 2-3 if the measure of the armature current is taken as value and sign (instrument at central zero).
Closed on the pins 1-2 if the measure is taken as absolute value (instrument at side zero). See JP14.

JP23 Personalization of the encoder zero pulse (terminal XM1-10);
Closed on the pins 1-2: contact XM1-10, XM1-5 normally open;
Closed on the pins 2-3: contact XM1-10, XM1-5 normally closed.

JP24 Personalization of the analog output PWM2, terminal XM1-39.
Closed on the pins 1-2 if the output is prearranged to have a milliamperemeter 5mA f.s. connected to the terminals XM1-39, 38.
Closed on the pins 2-3 if the measure has been taken live.

JP25 Exciter inside / outside Silcopac D.
Inserted on the pins 2-3 if the exciter is internal.
Inserted on the pins 1-2 if the exciter is external (Signal If connected to the terminal XM1-28).

JP26 Personalization of the encoder feed terminal XM1-5.
Closed on the pins 2-3 when the encoder is fed by the external power supply +24V connected to the terminals XM1-22, 23.
Closed on the pins 1-2 when the encoder is fed by a second external power supply whose voltages range from +5V to +24V.

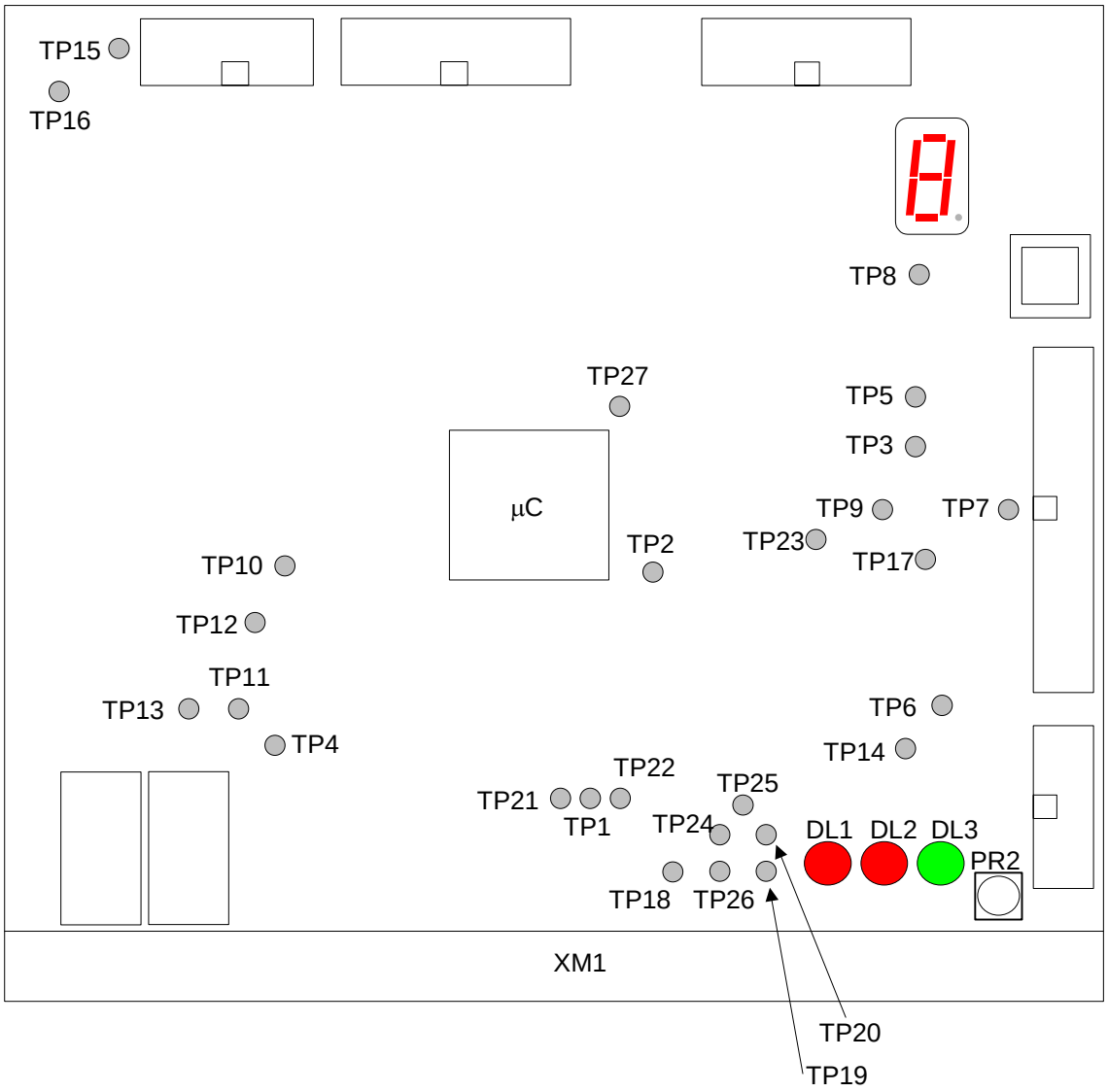
JP27 Personalization of the analog output PWM1, terminal XM1-37.
Closed on the pins 1-2 if the output is prearranged to have a milliamperemeter 5mA f.s. connected to the terminals XM1-37, 41.
Closed on the pins 2-3 if the measure has been taken live.

JP28 (reserved) Closed on the pins 1-2 (16 Mhz quartz).

JP50 Profibus expansion board.
Closed on the pins 1-2 when the expansion board which allows the serial connection with PROFIBUS protocol is used.
Closed on the pins 2-3 if otherwise.

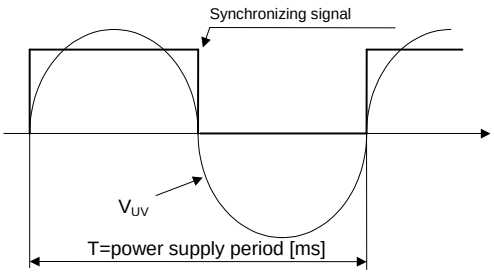
PR2 Trimmer for the Ia Monitor setting

C2.15 C Board test points



TP1 Signal 0 ÷ 10V terminals XM1-26, 27 (Tach).

TP2 Synchronizing signal.



TP3 Signal proportional to the armature voltage (not filtered) = Varm / 100.

TP4 +24 E (V)

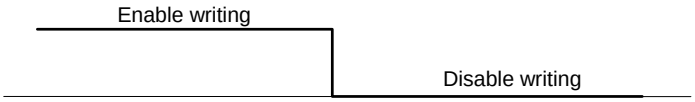
TP5 +5 V

TP6 +15 V

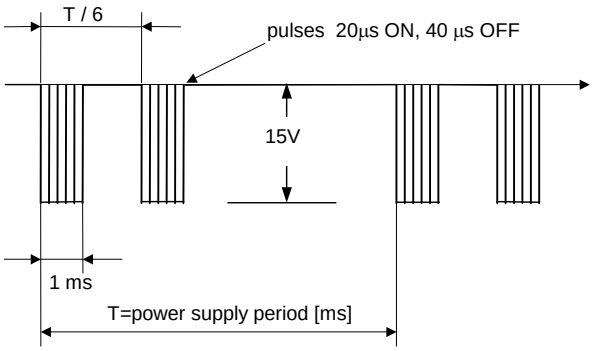
TP7 -15 V

TP8 0 V

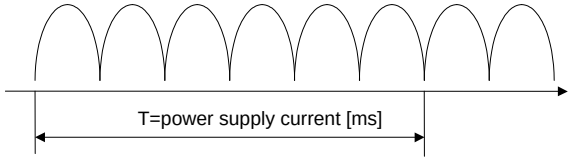
TP9 Disabling EEPROM writing at power up. See parameter CDA and jumper JP5.



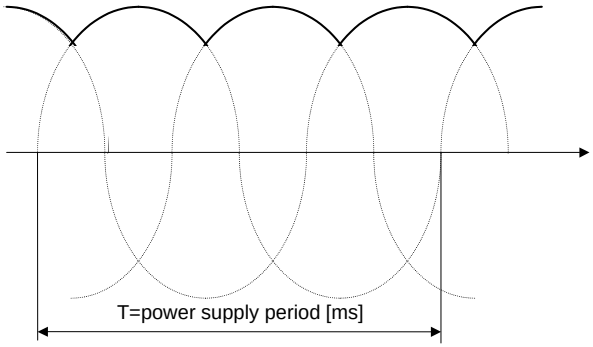
TP10 Signal U1 of the encoder, 24 V square wave.
TP11 Signal U3 of the encoder, 24 V pulse.
TP12 Signal U2 of the encoder, 24 V square wave.
TP13 0 V encoder (isolated from TP8).
TP14 Pulses for V1 thyristor switching on (Forward, Reverse).



TP15 0 V serial (isolated)
TP16 +5 V serial (isolated)
TP17 Signal proportional to the armature current, on load resistors R193-R194 of CT.

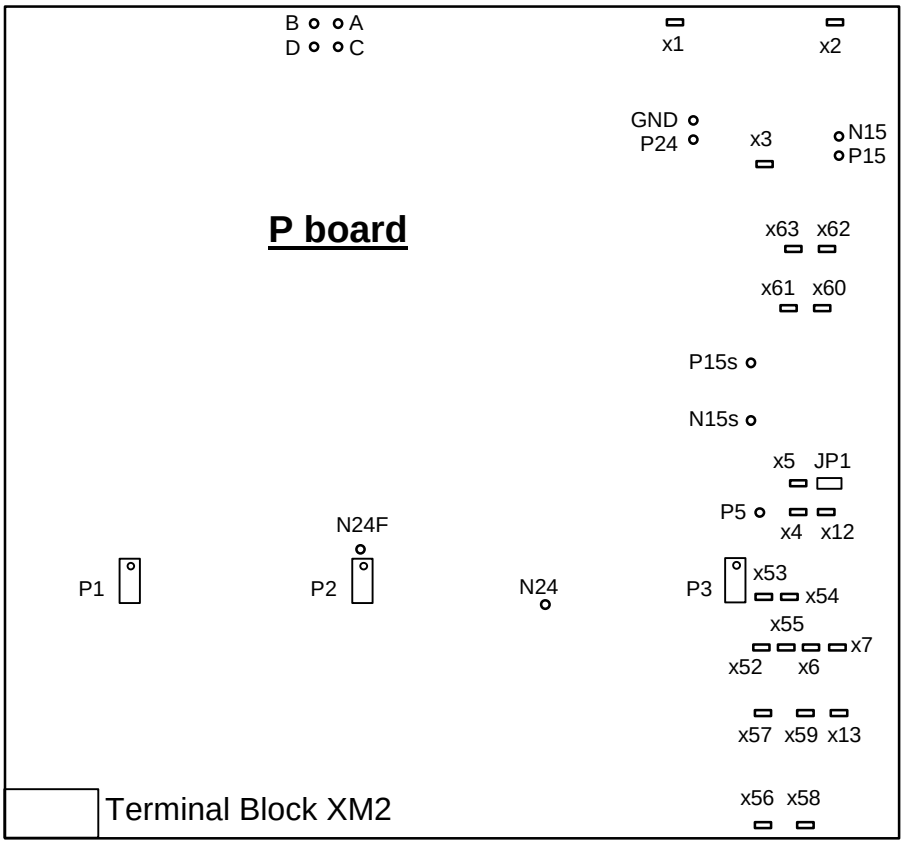


TP18 Analog input If terminals XM1-28, 31 (±10V) .
TP19 Analog input Ean1 terminal XM1-29 (± 10V).
TP20 Analog input Ean2 terminal XM1-30 (± 10V).
TP21 Signal proportional to the armature voltage (filtered, ± 10V). See terminal XM1-32, external voltage transducer.
TP22 Analog input Rif terminals XM1-33, 34 (± 10V).
TP23 Synchronism composition.



TP24 Analog output PWM1 terminals XM1-37, 38 (± 10V).
TP25 Analog output PWM2 terminals XM1-39, 41 (± 10V).
TP26 Analog output PWM3 terminals XM1-40, 41 (± 10V).
TP27 Signal of the XTAL oscillator of the SPDS1 board (RS485)
PR2 Trimmer for Ia Monitor setting

C2.16 P Board terminals and trimmers

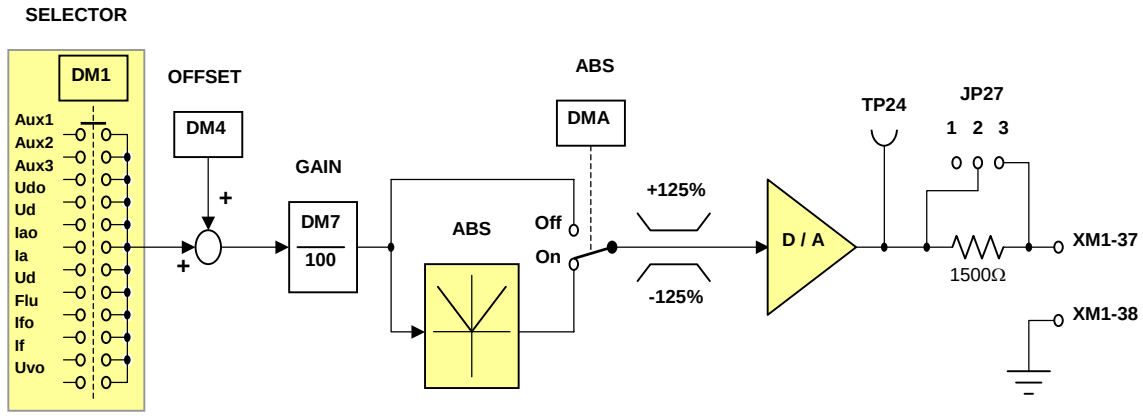


x1 - x2	Fastons for the connection of the armature voltage feedback Va on the snubber board.
x3	Armature feedback signal test point.
JP1	Reserved jumper (ventilation loss for parallel converters).
x4 - 5 - 12	Reserved fastons (ventilation loss for parallel converters).
x6 - 7 - 13	Reserved fastons (armature current for parallel converters).
x52 - 53	R176. Resistor for the magnetizing current compensation of TA1.
x54 - 55	R177. Resistor for the magnetizing current compensation of TA2.
x56 - 57	R193. CT load resistor (par. C2.3).
x58 - 59	R194. CT load resistor (par. C2.3).
x60 - 61	Jumper (reserved).
x62 - 63	Jumper (reserved).
A - B	Reversible converter connection.
C - D	Reversible converter connection.
A - C	Uni-directional converter connection.
P24	+24 V supply voltage test point.
P15	+15 V supply voltage test point; adjusted by trimmer P1.
P15s	+15 V held supply voltage test point.
P5	+5 V supply voltage test point; adjusted by trimmer P3.
GND	Control circuit 0V test point.
N15	-15 V supply voltage test point; adjusted by trimmer P2.
N15s	-15 V held supply voltage test point.
N24	-24 V supply voltage test point.
N24F	-24 V filtered supply voltage test point.

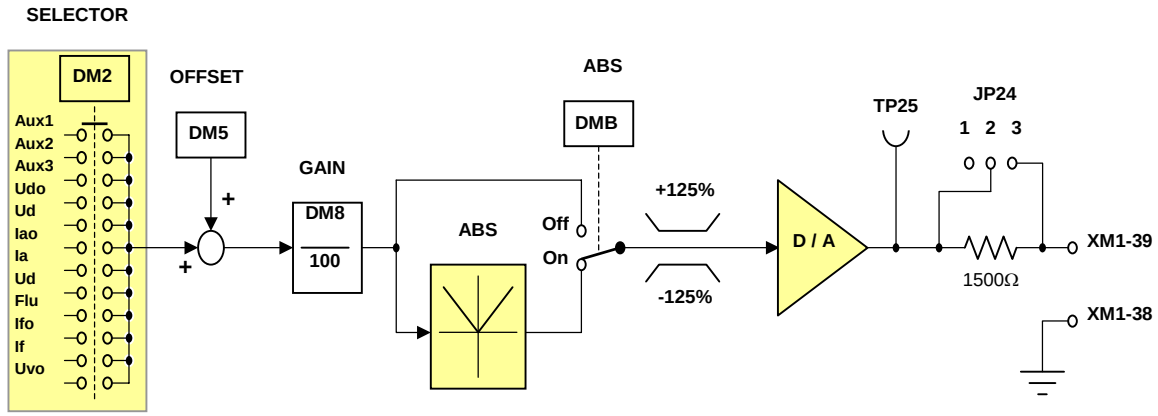
C Board: Terminals and Parameters.

All the analog outputs, excluded the output of the Ia-monitor (see paragraph C2.4.1), are programmable and their resolution is 8 bit + sign.

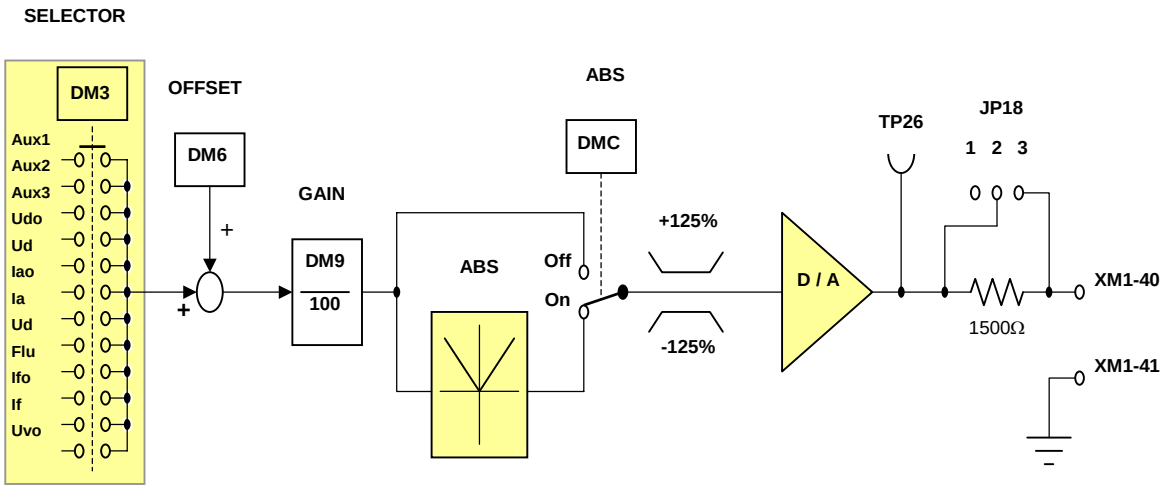
Analog output PWM1



Analog output PWM2



Analog output PWM3



C2.17 Speed self tuning complements

Speed Self tuning has been developed to correctly set the speed regulator in most cases. However, in some applications, it can give incorrect results; the cause is always due to mechanical problems (gears, oscillations, backlashes).

Standard Speed Self tuning procedure calculates Speed Regulator gains and the double pole filter bandwidth between the speed and the current regulators, measuring experimentally the machine acceleration time.
The acceleration time is the time (in seconds), that is necessary to the machine to start from zero up to Nominal Speed, when it is applied the Nominal Torque (Motor Nominal Current).
In those conditions, if the motor-machine coupling is not rigid (i.e. belt transmissions) the motor shaft torque is not fully applied to the machine (belt skidding), the Self tuning algorithm is not able to measure the correct acceleration time, and can calculate wrong values for gains and filter bandwidth.
In these conditions Speed Self tuning procedure can also be applied, decreasing proportionally the nominal current and the base speed values. In this way a reduced torque step is applied to the system, and it will reach a speed lower than base speed. See the following table:

example: Nominal current = 70%
Base speed = 80%

DB6	DB7	Description
70%	80%	They are the normal working conditions: during the Self tuning the motor reaches the base speed with a current step that is equal to the nominal current.
35%	40%	During Self tuning motor reaches half base speed and half nominal torque is applied to System.
17.5%	20%	During Self tuning motor reaches one fourth of base speed and one fourth of nominal torque is applied to System.
"	"	" " " " " " " " " "

Note: After self tuning set parameters DB6 and DB7 to their correct value (in the example DB7 = 70%, DB8 = 80%).

C3 TROUBLE SHOOTING

Most failure conditions that may occur to Silcopac D converter are continuously monitored by the fifteen (if enabled) internal protections, reducing failure investigation to the mere interpretation of the intervention cause.

Every time a failure condition occurs, it is then necessary to verify that Silcopac D internal protections are all enabled, or check for the cause that otherwise would have produced the intervention.

Some protections can be set as alarm, avoiding that their intervention locks the converter; in this case Silcopac D shows the alarms status that can be decoded referring to the PROTE & ALARMS function (par. C1.3.11) or to the DRIVE TRACE printout (par. C1.3.9).

C3.1 Protection intervention decoding

The occurred protection decoding is done through the user interface selecting the STATUS function (see par.: C1.1-C1.3.1-C1.3.11), or through the DRIVE TRACE printout (par. C1.3.9).

C3.1.0 P - 0	Line loss protection intervention; selecting the STATUS function (par. C1.3.1) the display shows PROTECTION MainF.	
This protection is made by a voltage supervisor hardware circuit (P15, N15 and P5). The protection intervention due to a P5 value higher than 5,25V or lower than 4,75V causes the converter reset sequence.		
FAIL. HYPOTHESIS	CHECKS	ACTIONS
Supply line voltage drop at terminals XM2-U, V, W, or loss of one phase, or presenza di buchi di rete di breve durata (notch).	Check the supply line voltage and the synchronisms	Restore the supply line.
Power supply failure.	The supply voltages are beyond tolerance. Measure the values at the test points: P5 - TP5; P15 - TP6; N15 - TP7. The 0 V reference is TP8; the intervention threshold are: P5 - +/- 5%, P15 and N15 +/- 20%.	If the supply voltage values are beyond tolerance, replace P board.
Control board failure.	The supply voltages are within tolerance values. Measure the values at the test points: P5 - TP5; P15 - TP6; N15 - TP7.The 0 V reference is TP8; the intervention threshold are: P5 - +/- 5%P15 and N15 +/- 20%.	Replace C board.
C3.1.1 P - 1	External protection intervention; selecting the STATUS function (par. C1.3.1) the display shows PROTECTION Ext_P.	
FAIL. HYPOTHESIS	CHECKS	ACTIONS
Logic signal loss at terminal XM1 - 20 (+ 24 v.)	Measure the voltage between terminals XM1 - 20, 22; it must be + 24 V $\pm$ 4 V. The logic input M20 Ext_P status, read through the Hardware Status function (par. C1.3.1) at the item Logic Input, will be OFF. If the voltage at the terminal is zero, the logic input status is ON and the protection occurs.	Re-enable the logic signal at terminal XM1 - 20, so as to measure + 24 V $\pm$ 4 V between terminals XM1 - 20, 22.
C board failure.	The voltage measured between terminals XM1 - 20, 22 is +24 V, the M20 Ext_P logic input status, read through the Hardware Status function (par.C1.3.1) at the item Logic Input, is ON.	Replace C board.
C3.1.2 P - 2	Max instantaneous current protection intervention; selecting the STATUS function (par.C1.3.1) the display shows PROTECTION IOC.	
The protection is made by a voltage supervisor hardware circuit connected to the CT load resistors (par.C2.3)		
FAIL. HYPOTHESIS	CHECKS	ACTIONS
Current loop is unstable or the response is too slow.	Check the current loop response (par. C2.10.4).	Execute the automatic adjustment of the current loop through the CURRENT SELFTUN. function (par. C2.10.1)
Armature short circuit.	Check the connections of the whole armature circuit from the converter bars to the motor.	Remove the short circuit.
A motor phase is grounded	Check the connections of the whole armature circuit from the converter bars to the motor.	Restore the proper circuit connection.
Thyristor failure	A thyristor is short circuited. Referring to Appendix D, bridge layout, check the electrical, check the electrical characteristics of the thyristors (par. C3.12).	Replace the fault thyristor pack.
Thyristor failure	A thyristor is short circuited. Referring to Appendix D, bridge layout, check the electrical, check the electrical characteristics of the thyristors (par. C3.12).	Replace the fault thyristor pack.
Supply line drop when the motor is in recovery condition (reversible converters only).	Check the supply line voltage. if the drop occurs on the synchronism too, the event is frozen on the DRIVE TRACE (par. C2.3.3).	

FAIL. HYPOTHESIS	CHECKS	ACTIONS
After a maintenance procedure, the connections of the synchronisms supply line and of the power circuits are not phased according to: XM2-U/AK1 - XM2-V/AK3 - XM2-W/AK5	Verify that the connections at terminal block XM2 and at the bars AK1-AK3-AK5 are made as described at par. A7.1.	Restore the proper synchronisms and power connection, taking attention to the proper phases sequence.
Over voltage on the motor armature during deceleration with field weakening.	Check the E.M.F.regulator tuning (paragraphs C2.9.1 e C2.10.3)..	
After a maintenance procedure, the connection from CN1, CN2, CN3, CN4 connectors on P board (for 2 quadrant SPDM CN3 and CN4 only) and the thyristors gate-cathode connectors are not in the proper sequence.		Restore the proper connection (see Appendix D - power circuits layout).
Failure of the CT load resistors voltage supervisor circuit.		Replace P board, If the failure persists replace the C board.

C3.1.3 P - 3	Watchdog protection intervention; selecting the STATUS function (par. C1.3.1) the display shows WATCHDOG .... (a)		
	Lista (a):	Sync_L	Eep_SP
		Sync_F	AInp_F
		Eepr_F	N<>0
		HwWdog	alfa < 50.
		Reset	MaxS
		ParDJ8	

The watchdog protection supervises the proper operation of the digital circuits.

FAIL. HYPOTHESIS	CHECKS	ACTIONS
Sync_L:synchronism voltage loss during a time grater than 100 ms.	Check the supply voltage at the terminal block XM2 (synchronism).	If the protection occurs in systematic way and it is not related to possible causes due to the supply line, replace C board.
Sync_F: synchronism loss due to noise.	Check if the supply voltage applied to terminal block XM2 (synchronism) is disturbed. On the DRIVE TRACE and on the THYRISTOR TRACE (par. C1.3.8 and C1.3.9) large firing angle (alfa) changes can be noted in static current conditions.	Modify the synchronism wires path, placing them far away of the possible noise sources. Insert a EMC filter on the synchronism. If the protection occurs in a systematic way and it is not related to possible causes due to noise on the synchronism, replace C board.
Eepr_F: Eeprom device failure or jumper JP4 isn't inserted or this last is inserted on pins 2-3	Check that jumper JP4 be closed on pins 1-2 (par. C2.8). If the device is fault, the protection occurs as soon as any parameters is modified.	Close jumper JP4 on pins 1-2. If the protection occurs at any parameter change, replace the EEprom device. If the EEprom replacement doesn't solve the problem, replace C board. If the failure persists replace P board.
HwWdog: microntroller supervisor		Replace C board.
Reset: the microcontroller was reset by a disturbance.	Check for the proper ground connections (par. A7.2). Check the efficiency of the filters placed on the devices installed in the cabinet. .	If the protection occurs in a systematic way, replace C board.
ParDJ8: the protection is active during the CURRENT SELFTUN. sequence only.	Check for the proper CT load resistor adjustment (par. C2.3).	Decrease the DJ8 parameter value (par. C2.3).
Eep_SP: Eeprom device auto-protection (a too large ac cess frequency to the device may be a failure cause).	It occurs only if a parameter change is requested through the serial link with a time period less than 40 ms. exceed 0,78. The value	In these cases it is sufficient that the modified parameters value abnormally acquired and not stored in the EEprom. Set CDA parameter to OFF. (The occurrence of this protection automatically sets the CDA parameter to OFF).
N < > 0: the protection is active during the CURRENT SELFTUN. only.	Check that motor field has been opened and that the rotor has been mechanically locked.	Open the motor field circuit. If needed, mechanically lock the motor rotor.
AInp_F: the protection is active during the OFFSET SELFTUN. only.	The voltage at the analog inputs must be lower than 0,78V. The voltage read on the analog inputs, through the Hardware Status function the Hardware Status function at the item Analog Inputs (par. C1.3.6), must be lower than 7.8%.	Null the signals connected to the analog inputs terminals (par. A7.1.1. Or, disconnect the signals themselves. If the protection occurs in a systematic way and it is not related to the connected signals, replace C board.
alfa < 50: the protection is active during the CURRENT SELFTUN. only.		The manual current loop adjustment is needed (par. C2.10.5).
MaxS: the protection is active during the CURRENT SELFTUN. only. CURRENT SELFTUNING has not been completed in 60 seconds.	Check that the value of the parameter TA1 TA2 TA3 and TA4 is the default value.	Repeat the self-tuning setting TA1 and TA2 at value different from default. If the failure persists do the manual tuning of the current regulator (par. C2.10.5).

C3.1.4 P - 4	Max armature voltage protection intervention; selecting the STATUS function (par. C1.3.1) the display shows PROTECTION Ud_F.	
FAIL. HYPOTHESIS	CHECKS	ACTIONS
The armature voltage exceeds the threshold value set by parameter DC5. The excitation current is too high. The speed is too high. Motor is weakened with a too short ramp time.	The data recorded on the DRIVE TRACE (par. C1.3.9) show that the armature voltage has exceeded the value set by DC5 parameter. The relationship with the field current value and with the speed can be examined.	Restore the exciter so that does not supply a field current too large. Avoid that the motor can be dragged. Increase the ramp time.
Armature voltage transducer failure or jumper JP7 isn't properly set.	The data recorded on the DRIVE TRACE (par. C1.3.9) show that the armature voltage has no coherent values. Set a firing angle reference through the Setup Reference function (par. C1.3.7); the armature voltage shown by the display has no coherent values (par. C2.2.7 point A).	Set properly the jumper JP7 (par.C2.8). Replace P board. If the failure persists, replace C Board.
C3.1.5 P - 5	Field loss protection intervention; selecting the STATUS function (par. C1.3.1) the display shows PROTECTION If_F.	
This protection supervises the signal level acquired at the If analog input. The connection from the exciter to C board is made according to the following configurations: -inside exciter SPAE1: through a flat-cable from X11 connector on C board to X11 connector of the SPAE1 (jumper JP25 closed on pins 2-3); (par. C2.8.1). - external exciter: through XM1 - 28 terminal (jumper JP25 closed on pins 1-2). (par. C2.8.2).		
FAIL. HYPOTHESIS	CHECKS	ACTIONS
Inside Exciter. Loss of the connection from C board to the exciter (through the P board).	The data recorded on the DRIVETRACE (par. C1.3.9) show that the field current is practically zeroed. The field current, read through the Hardware Status (par. C1.3.6) at the Analog Input item, is practically zero.	Set properly jumper JP25 (par. C2.8). Check the connection from the exciter to C board (through the P board).
Inside Exciter. The exciter doesn't receive the field current reference from C board (through the P board).	Check the setting of jumper INT/SPD on SPAE1 (par. C2.5.2) Check that DM2 parameter be programmed as Ifo. Check that DM5 and DM8 parameters be properly set (par. C2.8).	Execute the SPAE1 exciter customizing (par. C2.5). Execute the field current adjustment (par. C2.8).
Inside Exciter. The output field current is not correct.	Check the setting of jumper INT/SPD on SPAE1 (par. C2.5.2): Check the proper adjustement of the trimmer P2 on the SPAE1.	Execute the SPAE1 exciter customizing (par. C2.5). Execute the field current adjustment (par. C2.8).
Outside Exciter. The exciter doesn't receive the field current reference from C board .	Check that DM2 parameter be programmed as Ifo. Check that DM5 and DM8 parameters be properly set (par. C2.8).Check the connection between the SPDM and the exciter (par. C2.8.1-2)	
Outside Exciter. The protection occurs also if the exciter feed the right current.	Check that DJ2 parameter be programmed to read the field current, using Hardware Status function (par. C1.3.6) al the item Analog Input, equal to 100%.	
Fault Exciter. (with E.M.F. regulator disabled: CCA parameter set to OFF).	The data recorded on the DRIVE RACE (par. C1.3.9) show that the field current falls under the threshold value set by DC3 parameter. The field current, read through the Hardware Status (par. C1.3.6) at the Analog input item, has a value lower than the threshold set by DC3 parameter.	Replace the exciter
Inside Exciter. Fault or not adjusted exciter (with E.M.F. regulator disabled: CCA parameter set to ON).	The data recorded on the DRIVE TRACE show that the field current falls under the threshold value set by DC3 parameter or that the error between field current reference (Ifo) and feedback (If) is higher than 20%. The field current, read through the Hardware Status function (par. C1.3.6) at the Analog input item, has a value lower than the threshold set by DC3 parameter; or the error between this last one and the field current reference, read through to the Instrument Mode (par. C1.3.5) function visualizing item IF0, is higher than 20%.	Execute the field current adjustment (par. C2.8). It is possible that, due to a too short ramp time, the E.M.F. regulator force a field current reference change faster than the possible time as function of the motor field time constant; increase the ramp time. If the anomaly persist, replace the exciter.

C3.1.6 P - 6	Tacho generator loss protection intervention; selecting the STATUS function (par. C1.3.1) the display shows PROTECTION TachF.	
FAIL. HYPOTHESIS	CHECKS	ACTIONS
(Encoder feedback). Encoder signal loss.	The data recorded on the DRIVE TRACE (par. C1.3.9) show that the speed is zero while the armature voltage has a value higher than the value of the parameter DD2. Setting an angle reference, through the Set-up Reference function (par. C1.3.7) gives a zero speed and, connecting a scope to the test point TP10, TP11, TP12 and TP13 (par. C2.15) don't show the encoder pulses.	Check the encoder wires integrity and the proper connection to terminals XM1-6, 7, 8, 9. Replace the encoder.
(Encoder feedback). Encoder interface circuit failure.	The data recorded on the DRIVETRACE (par. C1.3.9) show that the speed is zero while the armature voltage has a value higher than the value of the parameter DD2. Setting an angle reference, the Set-up Reference function (par. C1.3.7) gives a zero speed and, connecting a scope to the test point TP10, TP11, TP12 and TP13 (par. C2.15) show the right encoder pulses.	Replace C board.
(Encoder feedback). Reversed encoder channels	The data recorded on the DRIVE TRACE (par. C1.3.9) show that the speed feedback has opposite sign in respect to the reference. Setting an angle reference on the forward bridge, the Set-up Reference function (par. C1.3.7) gives a negative sign of the speed.	Reverse the connections at the encoder terminals. Terminal XM1 - 6 to XM1 - 8 and terminal XM1 - 7 to XM1 - 9, terminal XM1 - 8 to XM1 - 6 and terminal XM1 - 9 to XM1 - 7.
(Tacho feedback). Tacho loss.	The data recorded on the DRIVE TRACE (par. C1.3.9) show that the speed is zero while the armature voltage has a value higher than the value of the parameter DD2. Setting an angle reference, the Set-up Reference function (par. C1.3.7) gives a zero speed and, the voltage at terminals XM1 - 26, 27 is zero.	Check the tacho-generator wires integrity and the proper connection to terminals XM1 - 26, 27. Replace the tacho-generator
(Tacho feedback). Erroneous settting of the Tach analog input (terminals XM1 - 26, 27).	Check the setting of Tach analog input customizing jumpers JP8, JP9, JP10, JP11, JP12	Set properly jumpers JP8, JP9, JP10, JP11 e JP12.
(Tacho feedback). Failure of the analog input acquisition circuit.	The data recorded on the DRIVE TRACE (par. C1.3.9) show that the speed is zero while the armature voltage has a value higher than the value of the parameter DD2. Setting an angle reference, the Setup Reference function (par. C1.3.7) gives a zero speed but the voltage at terminals XM1-26, 27 have its proper value.	Replace C board.
(Tacho feedback). Reversed tacho wires.	The data recorded on the DRIVE TRACE (par. C1.3.9) show that the the speed feedback has opposite sign in respect to the reference. Setting an angle reference on the forward bridge, the Set-up Reference function (par. C1.3.7), gives a negative sign of the speed	Reverse the connections at the tacho generator terminals.. Terminal XM1 - 26 on XM1 - 27 and terminal XM1 - 27 on XM1 - 26.
(Armature voltage feedback).	Check the proper tuning of armature voltage transducer (par. C2.7.3). Check that CB3 = F(Ud).	
C3.1.7 P - 1	Ventilation loss protection intervention; selecting the STATUS function (par. C1.3.1) the display shows PROTECTION Fan_F.	
FAIL. HYPOTHESIS	CHECKS	ACTIONS
Thermostat intervention due to a Heat sink overheat.	Check the ventilation efficiency.	Check the ventilation efficiency.
Broken thermostat connection.	Refer to chapter A6 for the thermostat connection in the respective converter sizes. Check the jumper JP1 on P board.	Restore the thermostat connections. Close the jumper JP1 of the P board (par. C2.10)
Failure of the thermostat	Refer to chapter A6 for the thermostat connection in the respective converter sizes. Check that the cold thermostat contact is normally closed.	Replace the thermostat.

C3.1.8 P - 8	Motor over temperature protection intervention; selecting the STATUS function (par. C1.3.1) the display shows PROTECTION MotOh.	
FAIL. HYPOTHESIS	CHECKS	ACTIONS
Excessive motor overload.	Check that in the machine linkage the frictions and/or the inertia haven't increased. Check for the proper gear box lubrication..	
Incorrect setting	Check the proper setting of the parameters DB3 and DB6.	
C3.1.9 P - 9	**Converter over temperature protection intervention; selecting the STATUS function (par. C1.3.1) the display shows PROTECTION ConOh.**	
FAIL. HYPOTHESIS	CHECKS	ACTIONS
Excessive converter overload.	Check that in the machine linkage the frictions and/or the inertia haven't increased. Check for the proper gear box lubrication..	
Incorrect setting	Check the proper setting of the parameters DA3 and DB3.	
C3.1.10 P - A	**Serial link loss protection intervention; selecting the STATUS function (par. C1.3.1) the display shows PROTECTION Ser_F.**	
FAIL. HYPOTHESIS	CHECKS	ACTIONS
Noise on the serial link.	Check for the proper ground connections. Check that the wire isn't near to noise sources. Check the efficiency of the filters placed on the devices installed in the cabinet.	Connect properly the ground wires. Modify the serial link wire path, placing it far away from possible noise sources. Insert some HF filters on the cabinet devices.
Serial link wire broken	Check the connections and the serial link wire integrity.	
RS485 Incorrect setting of the jumpers JP3 and JP6.	Check for the proper settings of the jumpers JP3 and JP6 (par. A9.3.1 and C2.14).	
RS485 RS 485 board failure.		Replace RS 485 board.
RS485 Serial interface circuit failure		Replace C board.
PROFIBUS Serial interface circuit failure		Replace Profibus board.
C3.1.11 P - B	**Max motor speed protection intervention; selecting the STATUS function (par. C1.3.1) the display shows PROTECTION NMax.**	
FAIL. HYPOTHESIS	CHECKS	ACTIONS
Current loop instability.	Check the current loop response (par. C2.10.4).	Execute the automatic adjustment Execute the automatic adjustment CURRENT SELFTUN. function(par. C2.10.1).
Speed loop instability.	Check the speed loop response. C2.10.4).	Execute the automatic adjustment of the speed loop through the SPEED SELFTUNING function (par. C2.10.2).
Motor is de-fluxed (E.M.F. loop instability).		Execute the automatic adjustment of the E.M.F. SELFTUNING function (par. C2.10.3)
Motor is de-fluxed (unadjusted exciter).	The data recorded on the DRIVE TRACE (para. C1.3.9) show that the field current value isn't congruent with the value requested by the motor characteristics. The field current value, read through, the Hardware Status function (par. C1.3.6) at the item Analog Inputs isn't coherent with the value requested by the motor characteristics.	Execute the SPAE1 exciter customizing (par. C2.8).
Dragged motor.	The data recorded on the DRIVE TRACE (par. C1.3.9) show that the speed feedback value is different from the reference and greater than the threshold set by the parameter DC4.	
Motor is de-fluxed (exciter failure).	The data recorded on the DRIVE TRACE (par. C1.3.9) show that the field current value isn't congruent with its reference. The field current value, read through the Hardware Status (par. C1.3.6) function at the item Analog Input, isn't coherent with the set reference (from C board:: jumper INT/SPD closed on SPD; from P1 trimmer:: jumper INT/SPD closed on INT).	Replace the exciter.

C3.1.12 P - C	Line voltage beyond tolerance protection intervention; selecting the STATUS function (par. C1.3.1) the display shows PROTECTION UvOut.	
FAIL. HYPOTHESIS	CHECKS	ACTIONS
The supply line had a change out of the range defined by DC1 and DC2 parameters.	The data recorded on the DRIVE TRACE (par. C1.3.9) show that the supply line has values out of the allowed range.	Restore the supply line.
C3.1.13 P - D	Motor in stall conditions protection intervention; selecting the STATUS function (par. C1.3.1) the display shows PROTECTION Stale.	
FAIL. HYPOTHESIS	CHECKS	ACTIONS
Mechanical motor lock	The data recorded on the DRIVE TRACE (par. C1.3.9) show that the motor is standing and in current limit conditions during a time longer than the value set by DC6 parameter.	Unlock the motor.
Field loss.	See par. C3.1.6.	See par. C3.1.6.
C3.1.14 P - E	Leg failure protection intervention; selecting the STATUS function (par. C1.3.1)) the display shows PROTECTION Leg_F.	
FAIL. HYPOTHESIS	CHECKS	ACTIONS
Fuses failure.	Find the causes that produced the fuses intervention (par. C3.8).	After having restored the system, replace the fault fuses
Main contactor open.	Check the commands sequence for the contactor closing according to the following logic: - contactor closing; - converter enable; - converter disable; - reached suppression status; - contactor opening.	Correct the commands sequence for the contactor closing.
Power supply line loss	Check the supply line voltage at the power bars.	Restore the supply line.
Thyristor failure.	One or more thyristors are fault (par. C3.12). It is possible to identify the pair of the fault thyristor according to the following procedure: column T of the THYRI-STOR TRACE at the protection intervention instant (par. C1.3.8 e C1.3.9) shows the number assigned to the pulsed thyristor pair (see table at par. C1.3.8 The bridge that was enabled in that moment depends on the current reference sign (Iao). Referring to Appendix D power circuits layout, the physical thyristor pair can be identified.	Replace the fault thyristor pack (par. C4.2).
Pulses amplifier circuit failure		Replace P board.
Pulses generator circuit failure.		Replace C board.
The connection from connector- X8 on C board to connector X8 on P board was left open (the connection is made by the proper flat cable).		Close the connection by the proper flat cable.
One of the connections from connectors CN1, CN2, CN3, CN4 of P board (for the 2 quadrant SPDM- CN3 and CN4 only) to the gate-cathode connectors		Close properly the connection (see Appendix D power circuits layout)
The connections between the connectors CN1, CN2, CN3, CN4 (for the 2 quadrant SPDM- CN3 and CN4 only) and the gate-cathode connectors not in the proper sequence		Close properly the connection (see Appendix D power circuits layout)

C3.2 THE MOTOR DOESN'T RUN

FAIL. HYPOTHESIS	CHECKS	ACTIONS
Start command is missing (terminal XM1 – 13).	If the start command is missing: - the voltage between terminals XM1-13, 22 is < than 20 V. - the Start logic command status read through the Hardware Status function at the item Logic Input (par. C1.3.6), is = OFF (M13 Start = OFF).	Check the enabling chain. If the voltage at terminals XM1–13, 22 is + 24 V ± 4 V, but the Start command status, read through the Hardware Status function at the item Logic Input (par. C1.3.6), is = OFF (M13 Start = OFF), replace C board.
The Enable command (terminal XM1 – 19) (parameter DN3 = Enable).	If the Enable command is missing: - the voltage between terminals XM1 – 19, 22 is < than 20V. - the Com3 logic command status, read through the Hardware Status function at the item Logic Input (par. C1.3.6), is = OFF (M19 Com3 = OFF).	Check the enabling chain. If the voltage at terminals XM1 – 19, 22 è + 24 V ± 4 V, but the Com3 command status, read through the Hardware Status function at the item Logic Input (par. C1.3.6), is = OFF (M19 Com3 = OFF), replace C board
Ramp command is missing (terminal XM1 – 14) (parameter CBD = OFF).	If the Ramp command is missing and the parameter CBD = OFF, the speed reference is forced to zero. If the Ramp command is missing: - the voltage between terminals XM1 – 14, 22 is < than 20V. - the Ramp logic command status, read through the Hardware Status function at the item Logic Input (par. C1.3.6), is = OFF (M14 Ramp = OFF).	Enable the Ramp command. If the voltage between terminals XM1 – 14, 22 è +24 V ± 4V, but the Ramp command status, read through the Hardware Status function at the item Logic Input (par. C1.3.6), is = OFF (M14 Ramp = OFF), replace C board
The speed reference is missing	The speed reference, read through the Instrument Mode (par. C1.3.5), with the converter enabled, is set to zero (No = 0).	Check for the proper setting, by CB1 parameter, of the speed reference origin. Check for proper operation of the speed reference generator devices.
The current reference is missing.	The current reference, read through the Instrument Mode (par. C1.3.5), with the converter enabled, is set to zero (Iao = 0).	Check for the proper setting, by CA1 parameter, of the current reference origin.. When the speed regulator is enabled, CA1 parameter must be set to N_Reg (CA1 IaoSl = N_Reg).
Erroneous current limits.	The current reference, read through the Instrument Mode function (par. C1.3.5), is limited to a value insufficient to overcome the mechanical friction. The converter goes in current limit conditions (see NOTE par. C1.3.1).	Check for the proper setting of the current limits. Check for the proper setting, by CA2 parameter of the current limit origin.
Armature open circuit	Check that the armature contactor be properly closed. Check the integrity of the armature fuses Check the connection of the armature wires. Check the status of the motor brushes	Restore the armature circuit.

C3.3 THE MOTOR DOESN'T REACH THE RATED SPEED

FAIL. HYPOTHESIS	CHECKS	ACTIONS
The speed reference doesn't reach 100%.	The speed reference value, read through the Instrument Mode (par. C1.3.5), doesn't reach 100% of its full scale value.	Restore the speed reference generator device. If the failure persists, replace C board.
The converter is in current limit conditions.	The converter in current limit status is shown by the Status function (par. C1.3.1); near to the item of list (a) the message I_L is shown. See also the Drive Parameters of group O-DIGITAL OUTPUT.	Check the proper setting of the current limits. Check for the proper setting, by CA2 parameter of the current limits origin. Decrease, if possible, the motor over-load.
The excitation current is higher than the motor plate value, but the conditions for the If_F protection intervention don't occur	The field current value (If), read through the Instrument Mode (par. C1.3.5), is higher than its reference (Ifo).	Check and, if fault, replace the exciter. Execute the SPAE1 exciter customizing (par. C2.5). Execute the field current tuning (par. C2.8).
The supply voltage is too low.	Check the supply voltage at the power bars	Restore the supply line.

C3.4 THE MOTOR IS OVERHEATED

FAIL. HYPOTHESIS	CHECKS	ACTIONS
Under-excited motor, but the conditions for the If_F protection intervention don't occur.	The field current value (If), read through the Instrument Mode function (par. C1.3.5),), is lower than its reference (Ifo).	Check and, if fault, replace the exciter. Execute the SPAE1 exciter customizing (par. C2.5). Execute the field current adjustment (par. C2.8).
Poor ventilation.	Check the proper direction of the motor fan. Check if the ventilation intakes aren't obstructed.	Restore the proper ventilation.
Too warm ambient.		Restore the ambient.
Improper commutation.		Check the wear status of the motor brushes and, if needed, replace.

C3.5 THE MOTOR STARTS TOO SLOWLY

FAIL. HYPOTHESIS	CHECKS	ACTIONS
Converter in current limit conditions	The converter in current limit status is shown by the Status function (par. C1.3.1); near to the items of list (a) the message I_L is shown. See also the Drive Parameters of group O – DIGITAL OUTPUT.	Check the proper setting of the current limits. Check for the pro per setting, by CA2 parameter, of the current limits origin. Decrease, if possible, the motor over- load.
Tuning of current and speed regulator		Do the current and speed regulator tuning according par. C2.10.

C3.6 SPEED OSCILLATIONS

FAIL. HYPOTHESIS	CHECKS	ACTIONS
Poor mechanical coupling from the motor to the Encoder or to the Tacho generator.	Check the coupling and the alignment.	Restore the proper coupling.
Wear of the tacho generator brushes		Wear of the tacho generator brushes
Speed loop instability.	A load increase could have Un aumento del carico potrebbe aver portato il regolatore in una zona di instabilità	Restore the proper load conditions or execute an automatic adjustment of the speed loop through the SPEED SELFTUNING function (par. C2.10.2).

C3.7 TORQUE OSCILLATIONS

FAIL. HYPOTHESIS	CHECKS	ACTIONS
Load eccentricity.	At constant speed the current, read through the Instrument Mode function (par. C1.3.5), oscillates in a synchronized way with the load mechanical change	Restore the proper mechanical conditions.
Oil loss in the gear box.		Restore the proper mechanical lubrication conditions.
Current regulator instability		Execute the adjustments of the current loop according the par. C2.10.1.

C3.8 OCCASIONAL FUSES INTERVENTION

FAIL. HYPOTHESIS	CHECKS	ACTIONS
Supply line drop when the motor is in recovery condition (4 quadrant converters only).		Restore the supply line.
Insulation defect of the installation.	Check the insulation between the phases and to ground.	Restore the proper insulation conditions
Current loop instability	Check the current loop response C2.10.4).	Execute the automatic adjustment of the current regulator through the CURRENT SELFTUN. function (par. C2.10.1).
Supply over voltages	Check the supply transients, particularly at the opening of the power transformer primary circuits or during the connection of power factor correction capacitors.	Restore the proper supply line conditions

C3.9 THE MOTOR DEMANDS TOO MUCH CURRENT

FAIL. HYPOTHESIS	CHECKS	ACTIONS
Excessive overloads	The armature current (Ia), read through the Instrument Mode function (par. C1.3.5), is higher than the rated motor current (see par. C2.3). For cyclic overload, evaluate the RMS current.	Decrease the work load cycles of the motor.
Under-excited motor (but the conditions for the If_F protection intervention don't occur).	The field current value (If), read through the Instrument Mode function (par. C1.3.5), is lower than its reference (Ifo).	Check and, if fault, replace the exciter Customize the SPAE1 exciter (par. C2.5). Execute the field current adjustment (par. C2.8).

C3.10 NOISE OF MECHANICAL COMPONENTS

FAIL. HYPOTHESIS	CHECKS	ACTIONS
Poor mechanical coupling.	Check the oil levels	Restore the proper lubrication conditions.
Poor mechanical coupling.	Check the mechanical coupling of the motor to the load.	Restore the proper mechanical work conditions.
Current loop instability	Check the current loop response (par. C3.9).	Execute the automatic adjustment of the current loop through the CURRENT-SELFTUN. function. (par. C2.10.1).

C3.11 NON CONTROLLED SPEED CHANGES

FAIL. HYPOTHESIS	CHECKS	ACTIONS
Disturbances on the regulation signals	Check for the proper connection of the ground wires (par. A7.2). Check that the reference and speed feed-back wires are not placing them far away of the possible near to noise sources. Check the efficiency of the filters placed on the devices wired in the cabinet.	Make the proper connection of the ground wires (par. A7.2). Modify the reference and speed feedback wires path, placing them far away of the possible noise sources. Insert some HF filters on the cabinet devices
Improper contacts on the regulation circuits.	Check the reference and speed feedback connections.	Make the proper connection.
Too slow response of the speed regulator.	Check the speed loop response (par. C2.10.4).	Execute the automatic adjustment of the speed loop through the SPEED SELFTUNING function (par. C2.10.2).
The converter goes in current limit conditions during a load transient		If a margin is available on the converter revise the CT load resistor adjustment, configuration (par. C2.3) and execute again the setting up.

C3.12 THYRISTOR FAILURE

FAIL. HYPOTHESIS	CHECKS	ACTIONS
Line over voltages.	If too high voltage is applied to the thyristor, it can be short circuited. Measuring by a multimeter,- if the anode to cathode resistance is near to zero, the thyristor is faulty.	Restore the proper supply line conditions. Replace the thyristor.

C3.13 CONSISTENCY ERROR

FAIL. HYPOTHESIS	CHECKS	ACTIONS
Parameter change not allowed. The value of the parameter that we will change is not compatible with other parameters. Or it enables some function that needs resources already used and so not available.	See chapter A10.5	See chapter A10.5

C4 MAINTENANCE

4.1 Periodic maintenance

The converter maintenance consists basically of a periodic inspection of the equipment. Take into account that the cleaning and installation in not too hot and vibration less environments are the main precautions to avoid malfunctions during working and they result into a long life of the components.

A clever attention even to small shortcomings upon the periodic inspections means a long life of the converter and avoids expensive works interruptions.

C4.1.1 Recommended periodic maintenance operations

- Once the power supply has been removed, clean carefully the inside of the power and control circuits, removing dust and dirt. A low pressure air blow or a vacuum cleaner can be used for cleaning, avoiding damage to the components.

- Check that all posts on the terminal blocks are well tight and that there are no loose components.

- Check that all press-on connectors (fastons) and the terminal blocks are firmly seated into their receptacles.

- It is important, especially in case of long operation cycles, to check the status of the contactor; replace periodically both the main and the auxiliary contacts. The malfunctions of the run contactor may compromise the proper converter operation.

- Check the motor brushes, collector and bearings according to the manufacturer instructions.

C4.2 Thyristors replacement

C4.2.1 Sizes I, II, III, IIIL and IIILL

For these sizes, insulated base thyristors are used; to replace these thyristors, operate according to the following sequence (refer to Fig. 1 and to the bridges layout in the appendix):

- Remove the converter power supply.
- Remove the closure front panel four fasteners.
- Disconnect the two connectors from XM1 terminal block, pulling them down.
- Disconnect the two flat cable connectors X8 and X9 from C board.
- Remove C board acting on the four attachment nuts (if RS485 options is installed, remove the protection cover forcing on the pressure fixing points and remove the board unscrewing the three nuts).
- Disconnect XM2 connector special bayonet cap.
- If SPAE1 exciter is installed, disconnect X11 connector from P board.
- Disconnect X10 connector from P board.
- Disconnect CN1, CN2, CN3 and CN4 connectors from P board.
- Remove P board acting on the four screwing turrets.
- Disconnect the contacts from the power bars.
- Remove the power bars fastened to the thyristors.
- Unstring the four small wires (two yellow and two red) connected to the gates and to the cathodes.
- Remove the screws fastening the thyristor to the heat sink; this operation must be executed unscrewing the screws alternatively.
- Clean with a swab of cotton and next apply on the new component surface a thin layer of silicon grease.
- Fasten the thyristor; this operation must be executed tightening the screws alternatively.

THYRISTOR TO HEATSINK FASTENING TORQUE

SIZE	TORQUE
30 to 260A	5 Nm
350 to 450A	2,5 Nm
500 to 1100A	5 Nm

- Re-connect the power bars.

BARS TO THYRISTOR FASTENING TORQUE

SIZE	TORQUE
30 to 200A	3 Nm
260 to 450A	5 Nm
500 to 1100A	9 Nm

- Connect the four small wires (two yellow and two red) to the gates and to the cathodes taking attention to the proper sequence (par. 3.2).
- Reinstall P board and connect the proper connectors.
- Reinstall C board and connect the proper connectors.
- Reinstall the closure front panel.

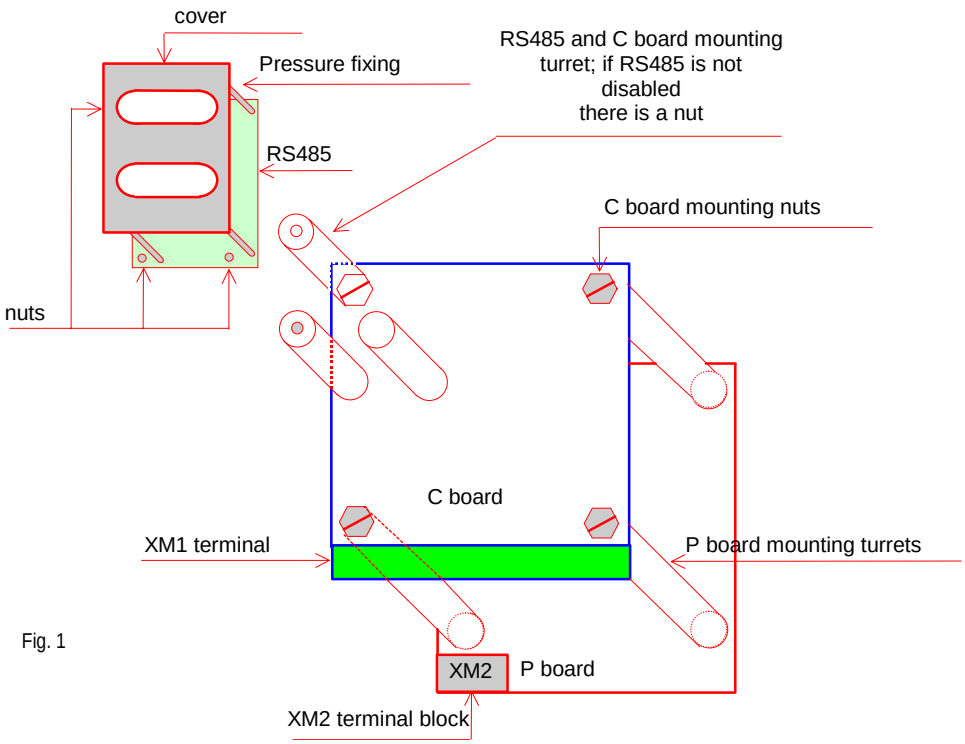


Fig. 1

C4.2.2 Size IV

For this size, disk thyristors are used; to replace these thyristors, operate according to the following sequence (refer to Fig 2 and Fig 3 and to the bridges layout in the appendix):

- Remove the converter power supply.
- Remove the closure front panel fasteners.
- Remove the Plexiglas protection panel fasteners.
- Free the boards holder acting on the proper groove fastenings and place it in position 1 to access to the central stacks or in position 2 to access to the upper stacks. The lower stacks are directly accessible.
- Unscrew the fastening nuts of the two lateral small bars connecting the fault stack.
- Unscrew the fastening nut of the fuse connected to the faulty stack and remove it.
- Disconnect all press-on connectors (fastons) connecting the faulty stack to the other circuits.
- Unscrew the four bolts fastening the cover to the carpentry and remove the stack pulling it toward the converter front side.
- Bench work, unscrew alternatively the two closure clamp screws and replace the thyristor disk cell (take attention to the two small centring pivots located between the cell and the heat sink).
- Remove the grease and dirt from the touching surface, apply on the heat sink a new layer of conductive grease (EJC2 or similar types) and place the cell on the heat sink itself by the two small centring pivots.
- Close the clamp screwing alternatively the two screws up to the unlock of the control tongue located into the central adjustment dynamometer spring bolt. Allow to the tongue a free but clutched rotation (the pad must be in the proper holder of the heat sink).
- Reinstall the stack.
- Connect all press-on connectors (fastons) in the proper position.
- Reinstall the fuse.
- Screw the bolts of the lateral small bars connecting the stack.
- Reinstall the boards holder and connect all connectors.

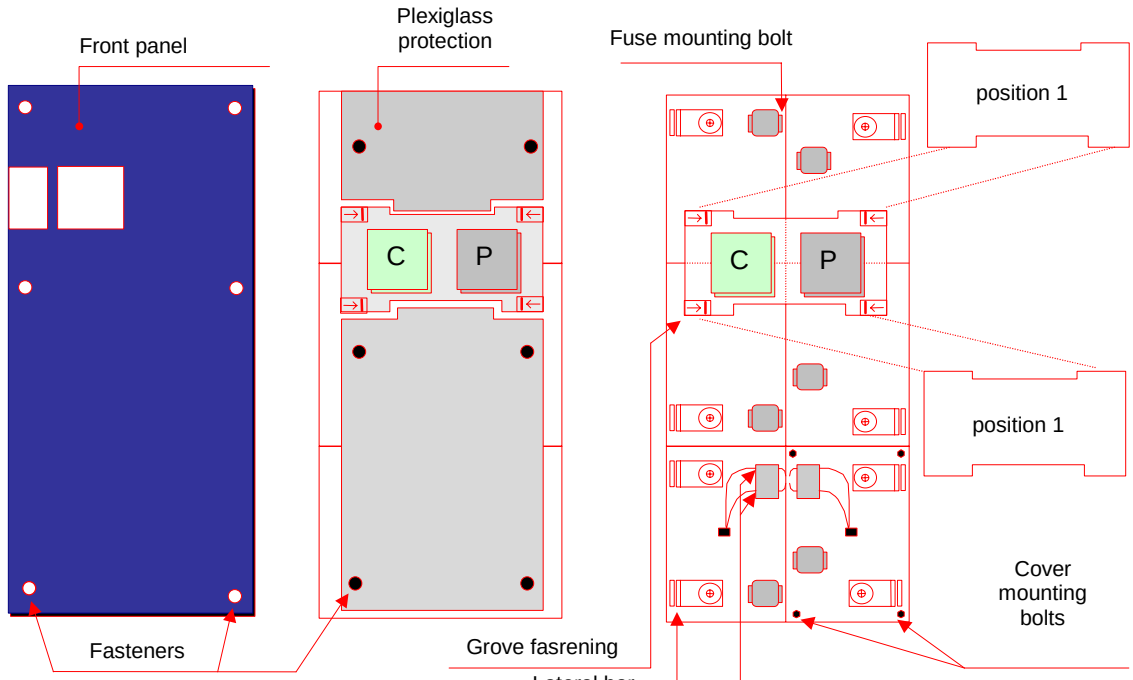

Front panel
Plexiglass protection
Fuse mounting bolt
position 1
C
P
C
P
position 1
Cover mounting bolts
Fasteners
Grove fasrening
Lateral bar mounting bolt
Faston connectors

Fig. 2

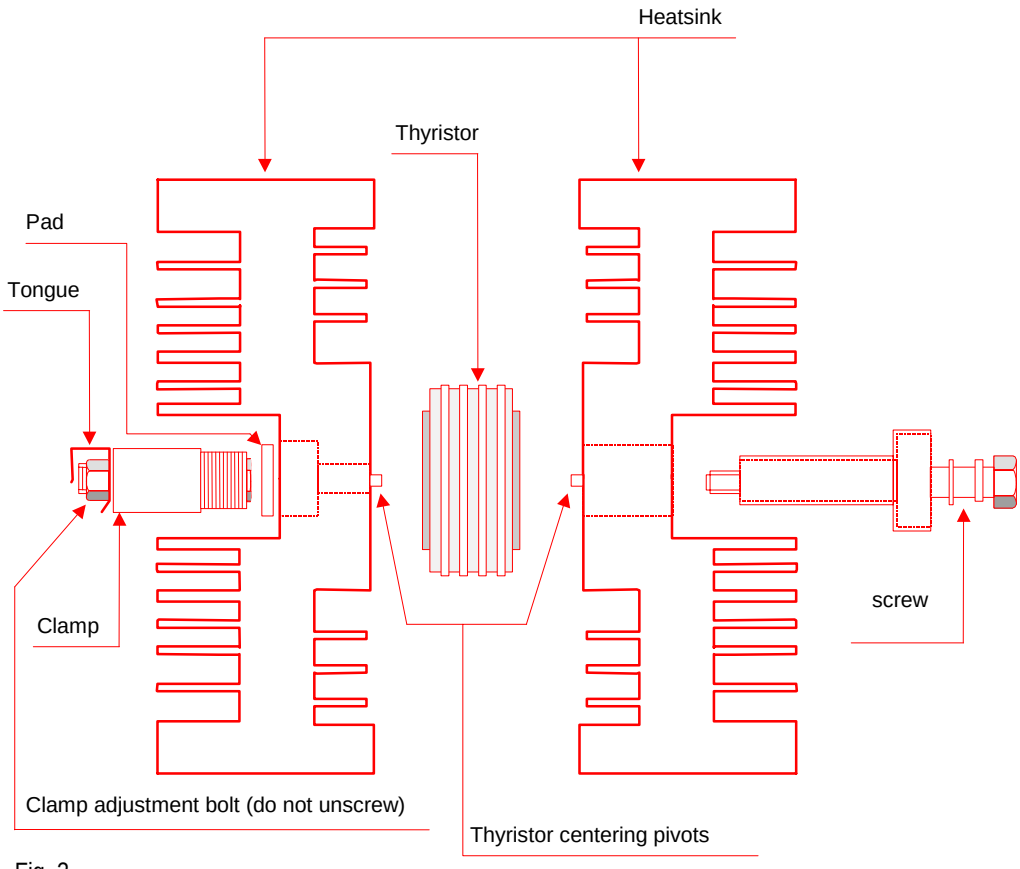

Heatsink
Thyristor
Pad
Tongue
Clamp
screw
Clamp adjustment bolt (do not unscrew)
Thyristor centering pivots

Fig. 3

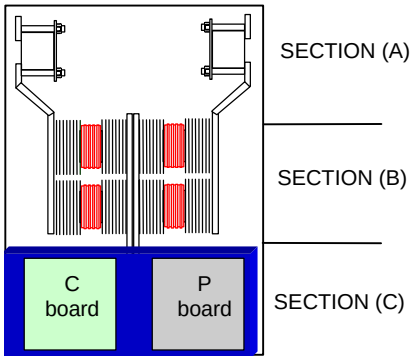
C4.2.3 Size V

For this size, disk thyristor are used; to replace these thyristors, operate according to the following sequence:

– Remove the converter power supply;

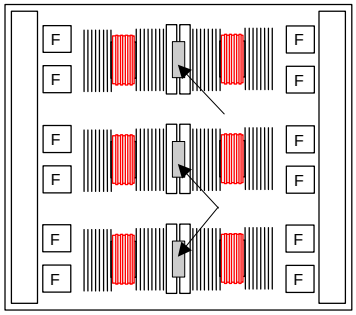
– Remove the closure front panel;

– In front view the drive can be divided into three sections:
upper section (A), in which there are the fuses;
central section (B), in which there are the thyristor stacks;
lower section (C), in which there are the control electronic boards;



– In section (B) are placed six stacks; each stack can contain one or two disk thyristors according to the type (unidirectional or reversible); each stack is a single unit so that the front stacks can be immediately removed, the internal stacks can be removed after having removed the front ones.

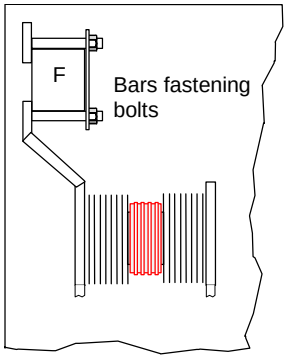
– In section (A), connected on the upper edge of central power bars, there are the terminals that connect the pulses cables coming from P board (section C) and the cables connected to the thyristors (gate/cathode); disconnect the cables coming from the P board from their terminals (write note of the connections);



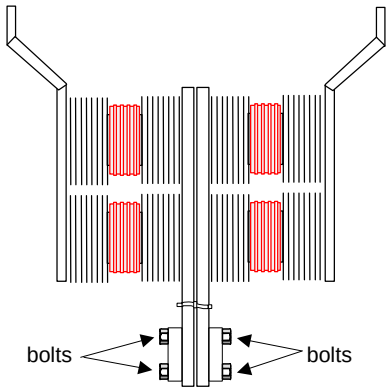
UPPER VIEW

– Separating baffles for energized sizes > K

– In section (A) the leg fuses are placed; the fuses are connected to the stacks bars by proper bolts; unscrew and remove the fastening bolts from the stacks bars that have to be taken out;



– In section (C), at the centre, the stack bars are connected to the AC power bars, each one by four bolts (two opposite couple); unscrew and remove the bolts to take out the stack groups;



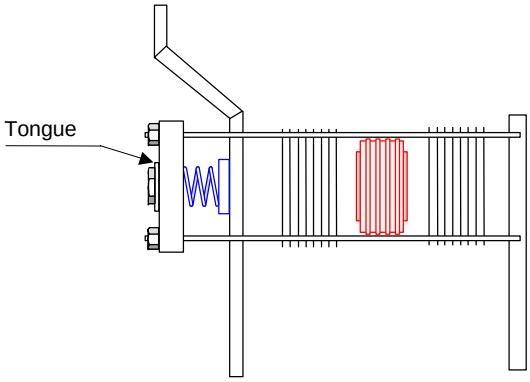
– If on the stack to remove is placed the thermostat, disconnect the two connecting cables;

– At this point the stack groups can be removed frontally making them slide on their proper slide bars;

– Bench work, unscrew alternatively the two closure clamp screws and replace the thyristor disk cell (take attention to the two small centring pivots located between the cell and the heat sink);

– Remove the grease and the dirty on the touching surface, apply on the heat sink new layer of conductive grease (EJC2 or similar types) and place the cell on the heat sink itself by the two small centring pivots;

– Close the clamp screwing alternatively the two screw up to the unlock of the control ring located into the central adjustment dynamometer spring bolt. Allow to the ring a free but clutched rotation.



– Reinstall the stacks;

– Tighten all opposite fastening bolts couple of the stacks to the AC power bars (section C);

– Tighten all stacks fastening bolts to the fuses;

– Connect all pulses cables to the proper terminals (section A);

– Install the closure front panels.

C4.3 Internal fuses replacement

Sizes IIIL ,IIILL and IV only have internal fuses located on the Graetz bridge arms.
For sizes IIIL and IIILL, remove the upper cover to have access to the fuses, unscrew the fastening screws and replace the fuses.
For size IV, to access to the fuses remove the cover and, if needed, unlock the boards holder and move it toward the lower side, unscrew the fastening screws and replace the fuses.
It is necessary to replace the fuses with those of identical type.

For size V, remove the cover of the upper section (A); the fuses are directly accessible and each is fixed with two fastening screw.

C4.4 Blower replacement

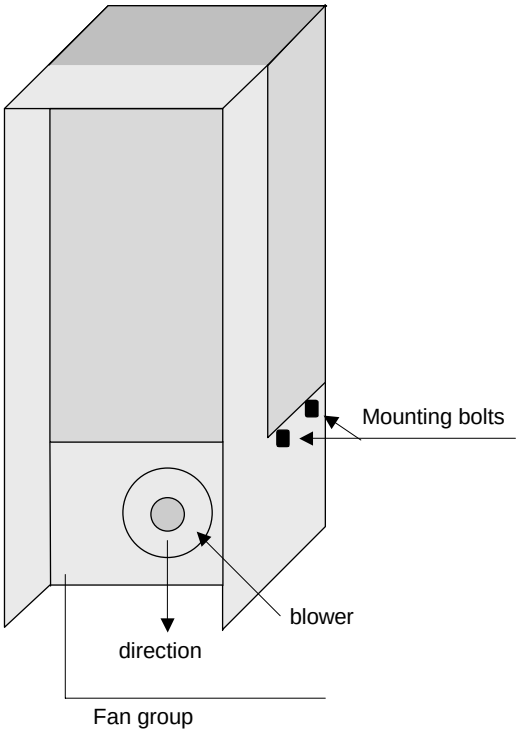
C4.4.1 Size II, III, IIIL and IIILL

Unscrew the four fixing bolts on both converter sides and pull down the holder/blower group.
On the bench, replace the blower by disassembling it from the holder.
Reinstall the holder/blower group and install the four bolts on both converter sides.

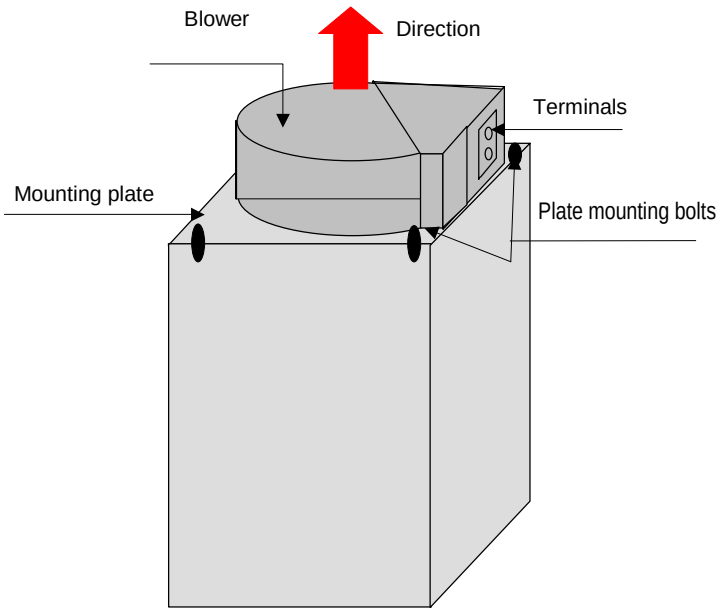
C4.4.2 Size IV and size V

The blower is provided detached and assembled on the cabinet by the user.
When the blower is placed on the converter, to replace it unscrew the plate fixing bolts and remove the group pulling toward the upper side.

FIG. 4



SIZES I, II, III, IIIL, IIILL



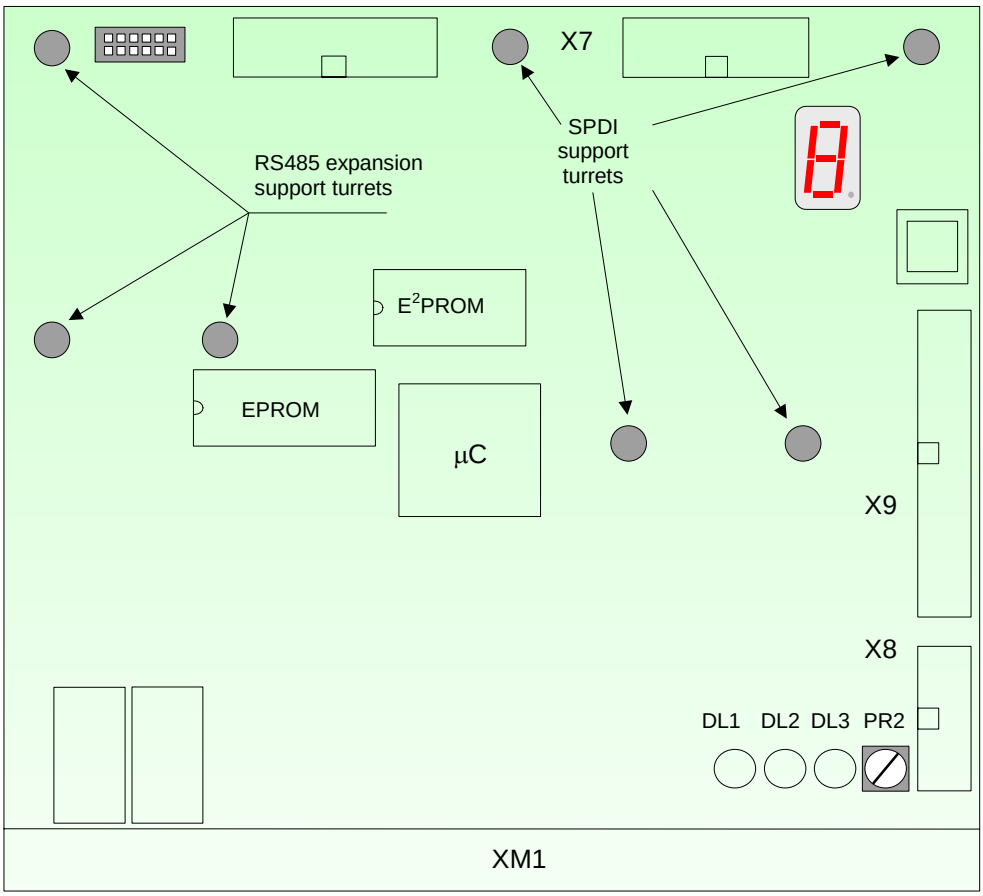
SIZES IV AND V

C4.5 C board replacement

All the converter control circuits (microprocessor, etc.) and the interface circuits thru the field (analogic input/output, commands, serial interface and parallel interface for SPDI1/SPDI2) are located on the C Board; the C Board replacement is needed only if trouble on the above mentioned circuits happens (see chapter 3 Trouble Shooting).

Sequence: (all sizes)

- Remove the converter power supply.
- Remove the closure front panel unlocking the special fasteners.
- Disconnect the two connectors from XM1 terminal block, pulling them down.
- Disconnect the two flat cable connectors X8 and X9 from C board.
- Remove C board acting on the four attachment nuts (if SPDS1 option is installed, remove the protection cover forcing on the pressure fixing points and remove the board unscrewing the three nuts - see par 4.2.1 figure 1).
- Remove the SPDS1 option support turrets, if installed, and reassemble them on the new spare C board (nuts on the back of the board).
- If the SPDI1 option is installed on board, remove it unlocking the four bayonet coupling supports.
- Remove the SPDI1 option support turrets, if it is installed, and reassemble them on the new spare C board (nuts on the back of the board).
- Using the special tool or delicately by a little blade screwdriver, lift and pull the component E^2PROM (U25) out of its base (pay attention, not to damage the component pins and check that they are completely inserted into their slots).
- Assemble the component pulled out from the faulty board on the new board respecting its position and direction (pay attention not to damage the component pins and check that they are completely inserted into their slots).
- On the top of the EPROM (U6) component there is a label with a printed code; verify that the code of the EPROM installed on the new spare board and the code of the EPROM installed on the faulty board are equal. If the two codes are not equal then, lift and pull the EPROM of the two boards out using the same previous cautions; reinstall then the EPROM pulled out from the faulty board on the new spare board (pay attention, not to damage the component pins and check that they are completely inserted into their slots).
- Check that the jumper configuration of the spare board is equal to that of the faulty board; otherwise customize correctly the spare board.
- Reinstall the new C board and insert the proper connectors.
- Reinstall, if present, the SPDS1 and SPDI1 options and insert the proper connectors.
- Reinstall the closure front panel.
- Reinstall the components pulled out from the new board on the bad board and send it to Ansaldo for repairing.
- It is necessary to repeat the sequence described at the par. 2.4.1 to calibrate the Ia_Monitor.
- It is also necessary to repeat the offset self tuning on analogic inputs as described at par. 2.4.3.



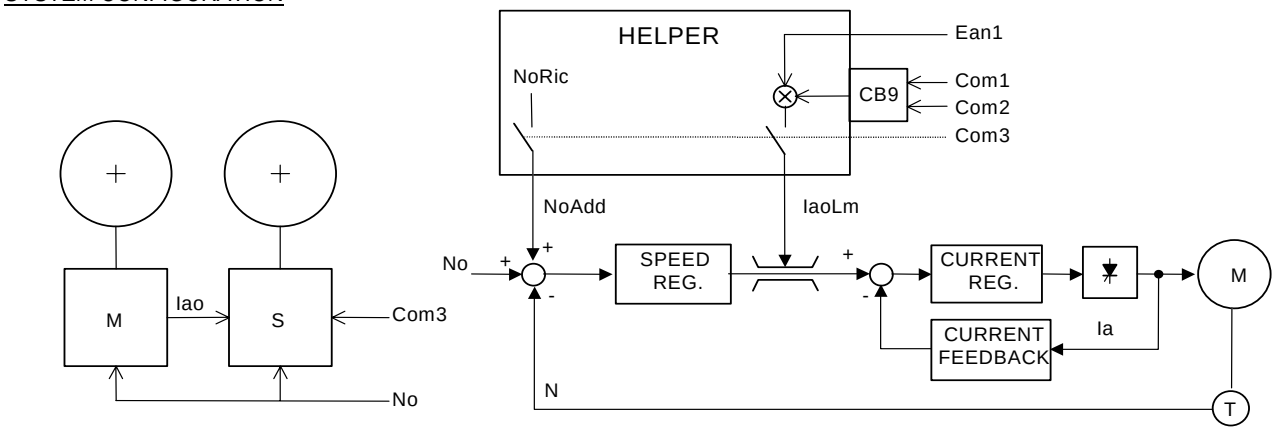
N.B.: Apply the following procedure in order to replace a CONDA card with a CONDB card:

- Replace EEPROM component housed on the pre-existent card with the one situated on the new card in order to reuse the parameter configuration.
- Remake the gauging of the armature voltage transducer as described in section C par. 2.6.2a.
- Remake the gauging of the tachometric voltage transducer (if used) as described in section C par. 2.6.2b.
- Personalize the jumper configuration (apart from the jumpers relating to the above-mentioned transducers) in order to obtain the same functionalities set on the previous card (see the description made in section C par. 2.8).
- Insert the extractable terminal boards XM1, lining them up the left side of CONDB card so that the terminal XM1-42 is free on the right side of it (all other contacts are compatible).

D AUXILIARY FUNCTIONS

D1 Helper

SYSTEM CONFIGURATION



This function controls the load sharing between two drives when their motors are mechanically coupled.

MASTER converter

Master converter must deliver an analog signal (+/- 10V) proportional to the armature current reference, programming one of the DM1, DM2 or DM3 parameters as Iao then one of the three PWM1, PWM2 or PWM3 analog outputs (terminals XM1-37, 38; XM1-39, 41; XM1-40, 41) is set as current reference for the slave converter.

SLAVE converter

Parameters:

CEA = ON	Helper aux function enabled.
CB2 = AuxAdd	Term to be summed to the speed reference from aux function.
CE1 = 10%	Value of the speed reference summing term.
CA2 = AuxRic	Current limit control from aux function.
DN3 = OFF	
CB4	program with the value of the ramp time for the motopotentiometer which is used for the load share.
CB9	program with the value of the load share (%).
CBE	program with the value ON to store the value of the load share.

Slave converter receives the armature current reference from the Master converter at the Ean1 analog input (terminals XM1-29, 31).

SLAVE converter commands

Com3	(terminals XM1-19) Helper function enable.
Com1	(terminals XM1-17) Ean1 analog input recalibration (INCREASE).
Com2	(terminals XM1-18) Ean1 analog input recalibration (DECREASE).

Function description

Com3	input is not active: the function is disabled: the converter is speed regulated and the active current limits are those set by TA3 and TA4 parameters.
Com3	input is active: the function is enabled; the speed regulator will be forced to saturate enabling the speed reference summing term defined through the CE1 parameter (invitation speed).

To allow the speed regulator saturation even at the maximum reference, program TC4 and TC5 parameters according to the following formula:

$TC4 = TC4_P + CE1$ where $TC4_P$ = TC4 parameter previous value;

$TC5 = TC5_P - CE1$ where $TC5_P$ = TC5 parameter previous value;

The upper current limit is acquired at Ean1 analog input that is driven by the Master converter.

Commands Com1 and Com2 act on the DJ3 parameter which recalibrates the Ean1 analog input (Com1 = increase; Com2 = decrease) allowing load share. The resulting torque is however a (variable) percentage of the Master converter torque.

If the Helper (slave) converter slips, then the speed regulator goes out of its saturation status and avoids the motor exceeding the master speed plus the invitation speed.

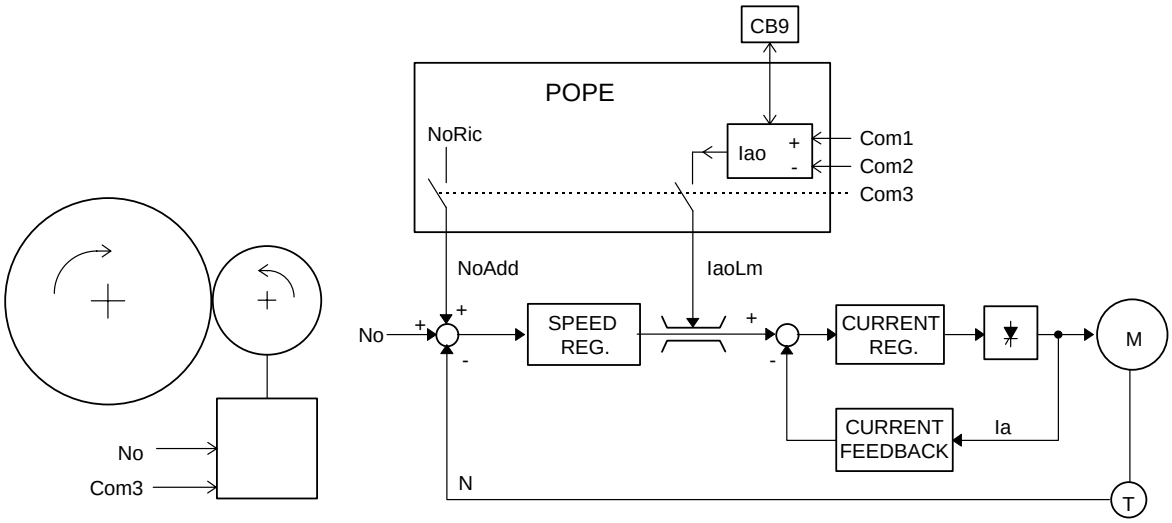
If the speed reference has a negative value, the function drives the lower current limit and the term related to the invitation speed will be subtracted.

On the Com3 command falling edge the DJ3 parameter is written in the EEprom memory to store the last imposed load share.

Note ##: Pwm2 analog output is normally reserved to the field current reference.

D2 Pope

SYSTEM CONFIGURATION



Parameters:

CEB = ON	Pope aux function enabled.
CB2 = AuxAdd	Speed reference summing term from aux function.
CE1 = 10%	Speed reference summing term .
CA2 = AuxRic	Current limit control from aux function.
DN3 = OFF	
CB4	Program with the value of the ramp time for the motopotentiometer which is used for the load share.

Commands

Com3	(terminal XM1-19) Pope function enable.
Com1	(terminal XM1-17) current limit recalibration (increase).
Com2	(terminal XM1-18) current limit recalibration (decrease).

Function description

Com3 input not active: the function is disabled; the converter is speed regulated and the active current limits are those set by TA3 and TA4 parameters.

Com3 input active: the function is enabled;
the speed regulator is forced to saturate enabling the summing term to the speed reference defined by CE1 parameter (invitation speed). Set TC4 and TC5 parameters according to the following formula:

$TC4 = TC4_P + CE1$; where $TC4_P$ = TC4 previous value;
$TC5 = TC5_P - CE1$; where $TC5_P$ = TC5 previous value;

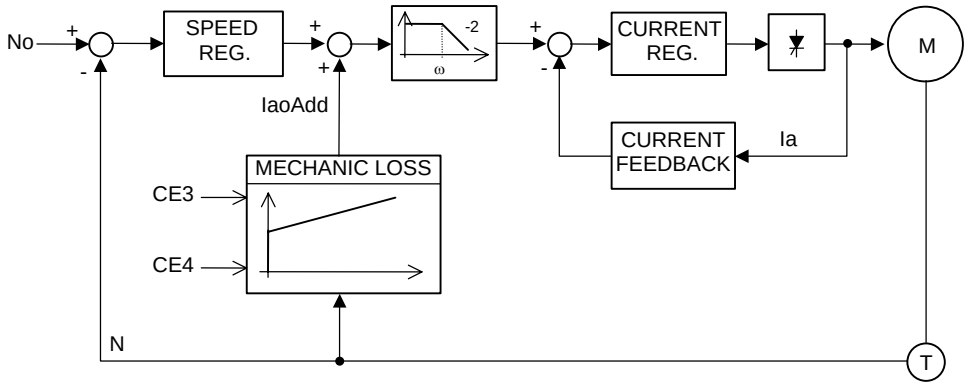
to allow the speed regulation saturation at the max reference value too.

The current reference value that is active at the Com3 rising edge will be stored and substituted to the upper current limit.
Commands Com1 and Com2 act on the stored current reference (Com1 = increase; Com2 = decrease) increasing or decreasing thus the applied tension (the slope can be programmed by the CB4 parameter).

At the Com3 falling edge, the speed reference summing term will be immediately zeroed and the current upper limit will be acquired again by TA3; the Speed Regulator is immediately desaturated zeroing the integral term and the speed error. If the slope is enabled (TE1 and TE2 parameters), the bumpless disconnection of the Pope function is thus obtained: it allows the passage from current regulation to speed regulation without discontinuities in the current reference.

D3 Mechanical friction compensation

SYSTEM CONFIGURATION



Parameters:

CED = ON	Mechanical friction compensation aux function enabled.
CE3	See description.
CE4	See description.
CA3	Program with the value "AuxAdd" when not used with the optional function Winder.

Function description

The function compensates the mechanical friction losses according to the following formula:

$$Comp = CE3 + [(N \cdot CE4) / K]$$

where:

Comp:	current reference summing term needed to compensate the mechanical friction losses.
CE3:	mechanical friction rate not depending on the speed.
CE4:	coefficient depending on the mechanical friction rate as linear function of the speed.

Practical procedure for the experimental evaluation of CE3 and CE4 parameters:

1) Through the Setup Reference function (section C, par. 1.2.7), set a speed reference equal to 1% of the nominal speed.
2) Read $Ia_{(SR)}$ value (section C, par. 1.2.7 point "A"): current needed to compensate the mechanical friction at this speed. Set CE3 parameter with $Ia_{(SR)}$ value (constant rate of the mechanical friction).
3) Through the Setup Reference function (section C, par. 1.2.7), set a speed reference equal to 100% of the nominal speed.
4) Read $Ia_{(SR)}$ value (section C, par. 1.2.7 point "A"): current needed to compensate the mechanical friction at this speed. Set CE4 parameter according to the following formula:

$$CE4 = (Ia_{(SR)} - CE3).$$

The term evaluated for the frictions compensation will be summed to the current reference delivered by the speed regulator before the dual slope digital filter.

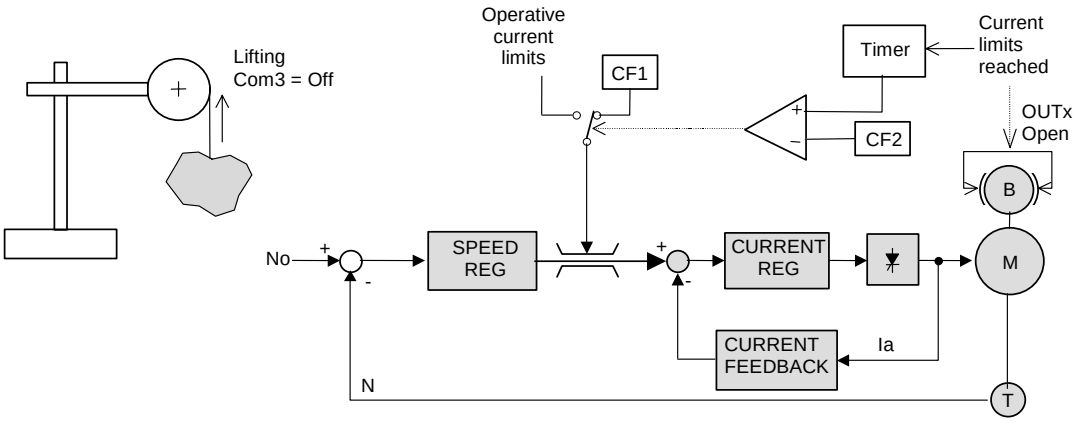
In the case of negative speed feedback, the mechanical friction compensation gives a negative summing term (correction < 0).

It is possible to display the term evaluated for the mechanical friction compensation by setting one of the parameters DG5, DG6 and DG7 with the M_Loss value.

D4 Torque proof

The function is used for the lifting applications. The function purpose is to reduce or to remove the speed transient that occurs at the brake opening time.
Before brake opening the motor is controlled by a limited torque (torque preset) so not to damage the motor/brake system and to ensure a quick transient after the brake opening.

SYSTEM CONFIGURATION



Function description

The function is enabled by the parameter CFB = ON and digital input COM3 = OFF.
When the system is in suppression status (STATUS = SUPPR), the current limits are preset to the range (+/-) set by parameter CF1. The motor at the start will be fed by that current value

BRAKE OPENING

The brake opening/closing command is given by a logic output OUT1-OUT6 (parameters DO1-DO6) set as '*T_proof* '.
When start command is given (transition the the regulation status, STATUS = REGUL), the brake is locked till the system reaches the current limit set by parameter CF1. The current limits set by parameters TA3 and TA4 do not care.
The status "system in current limits" can be carried out to a digital output (see the parameters DO1…DO6) or displaied on the keypad (see NOTA 3 paragraph C1.3).
The brake opening is commanded when the current reaches the set limits and at the same time a timer is set (time setting by the parameter CF2 in software cycles,) at the time end the current limits go back to the values set by the parameters TA3 and TA4.
The delay required to go back to the previous limits balances the delay for opening the brake and then avoids that the motor generates the maximum torque with the brake still closed (brake opening transient).

BRAKE CLOSING

The brake will be closed when the motor reaches the zero speed after the stop.

Parameters

Parameters:	value	Function
CFB	ON	Torque-Proof aux function enabled.
CF1		See description.
CF2		See description.
CA2		Limit current source selection. Program the value Fixed.
Dox		Digita output OUTx for brake opening/closing operations. Set to ' *T_proof* '.
Commands	Function	
COM3	(terminal XM1-19) not active: function enabled.	

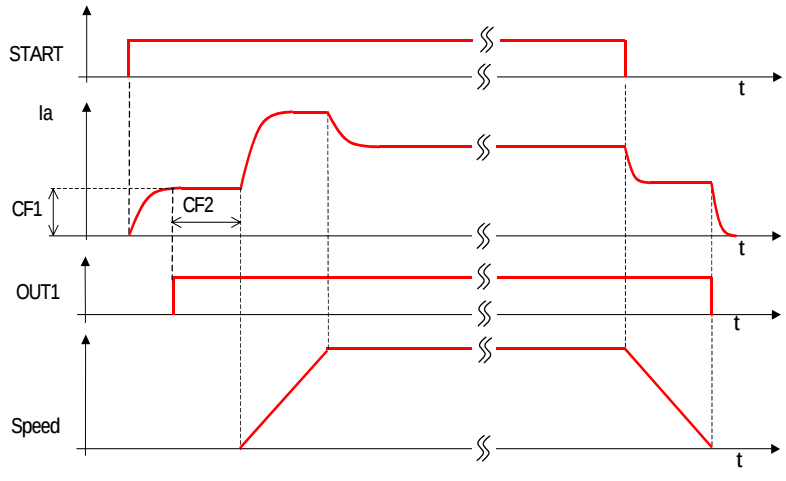
Exemple: The picture shows the typical trend of the motor current and speed during a lifting operation

At the start the current rises to the limit value CF1 in a time that is a function of the current regulator tuning.

When the CF1 value is reached the digital output OUT1, set to '*T_proof* ', goes high and opens the brake.

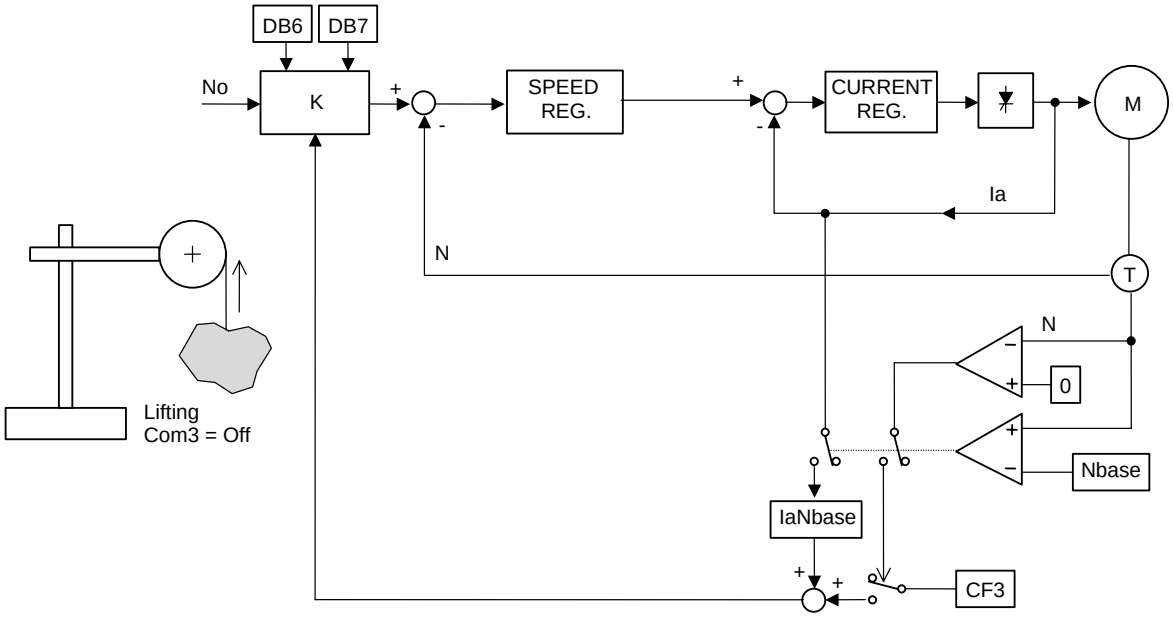
After the delay, set by CF2, the current limits go back to the values set by the parameters TA3 and TA4 and, if the brake is unlocked, the motor starts.

At the Stop, the motor decelerates till zero speed, at this moment the digital output OUT1 goes back to low status and close the brake.



D5 Load weighing

SYSTEM CONFIGURATION



Parameters:

CFC = ON	Load weighing aux function enabled.
CF3	Plan with friction torque compensation during the lowering.
CF6	Plan with time required to carry out load weighing (each unit corresponds to 2 software cycles, equal to 20 ms if CD3 = 10ms).

Commands

Com3 (terminal XM1-19) not active: function enabled.

Function description

The function, used in lifting applications (cranes, etc.) which operate with de-fluxed motors, allows to always obtain maximum motor speed, according to the required torque. This is done by recalibrating the speed reference value on coefficient K, so as to avoid the motor current exceeding the nominal value in steady state conditions.

At the beginning, before weighing (motor speed is zero), the recalibration coefficient is:

$$K_0 = \frac{DB7}{100\%}$$

with DB7 as base speed.

Weighing and speed reference recalibration are only performed when the motor reaches base speed; considering K start value, base speed is only reached if speed reference is set to 100%. On reaching base speed, armature current Ia(Nbase) is measured and recalibration coefficient K is recalculated as follows:

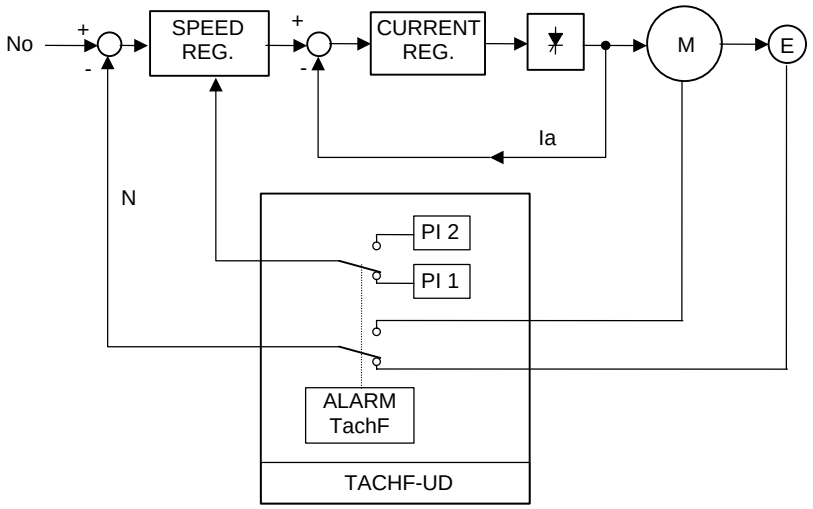
$$K = \frac{DB6}{Ia_{(Nbase)}} \cdot DB7$$

with DB6 as nominal current and DB7 as base speed.

Ia(Nbase) is the average current calculated within a time interval set by parameter CF6, expressed in software cycles (see parameter CD3), during which speed is kept equal to base speed.
The whole speed recalibration procedure requires twice the time set by CF6.
CF3 parameter is used to compensate the friction torque during the lowering; it is adjusted so that the lifting and lowering speed of the system, with the same load, are equal.

D6 Speed feedback switching

SYSTEM CONFIGURATION



Parameters:

CBG = ON Speed feedback switching aux function enabled.

TH7
TH8 } PI 2

DCG = OFF Tacho loss protection disabled.
DDA See description.

Function description

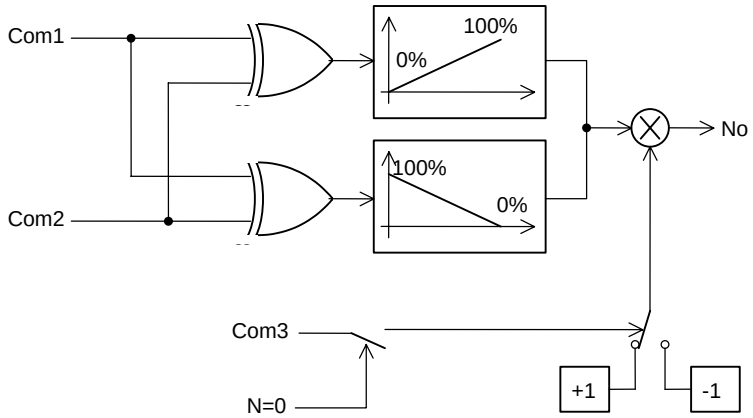
This function acts when the condition for the tacho loss protection occurs, i.e. either when armature voltage exceeds by 50% its rated value, with no tacho (or encoder) feedback, or if tacho (or encoder) feedback sign is inverted.

This function replaces the tacho/encoder speed feedback value with the value calculated depending on armature voltage [CB3 parameter will be automatically set to F(Ud)]. Flux reference is assumed equal to the value set by CC4 parameter.
The speed regulator gains are replaced with those set by TH7 and TH8 parameters (proportional and integral only).
The system signals tacho loss alarm status (DDA parameter is automatically set to ON). In this case, tacho loss alarm can not be reset; it can be sent to any logic outputs by setting one of DO1,..., DO6 to “Alarm”.

When the system is restored, the original configuration is resumed by a reset sequence.

D7 Motopotentiometer

SYSTEM CONFIGURATION



The software motopotentiometer can be used as speed reference source to generate the speed reference when CB1 parameter is set to 'MPotFw' or 'MPotC3'.

The function is handled through the logic commands COM1, COM2 and COM3 (terminals XM1 - 17, XM1 - 18 e XM1 - 19 respectively. See Section A of this Manual, par 7.1.1).

CB1 = MPotFw: forward motopotentiometer.

It is possible to set a 0 to +100% reference; Com1 active command increases the reference value; Com2 active command decreases the reference value.

COM1	COM2	Reference
0	0	Constant
0	1	decrease (min 0%)
1	0	increase (max 100%)
1	1	Constant

CB1 = MPotC3: motopotentiometer with sign from Com3.

It is possible to set a -100% to +100% reference; Com1 active command increases the reference absolute value; Com2 active command decreases the reference absolute value; Com3 command is acquired only at zero speed (see relay K1) and, if active, assigns the - sign to the reference; if it is not active, it assigns the + sign to the reference.

COM3	COM1	COM2	Reference
0	0	0	constant with (+) sign
0	0	1	from +100% toward 0%
0	1	0	from 0% toward +100%
0	1	1	constant with (+) sign
1	0	0	constant with (-) sign
1	0	1	from -100% toward 0%
1	1	0	from 0% toward -100%
1	1	1	constant with (-) sign

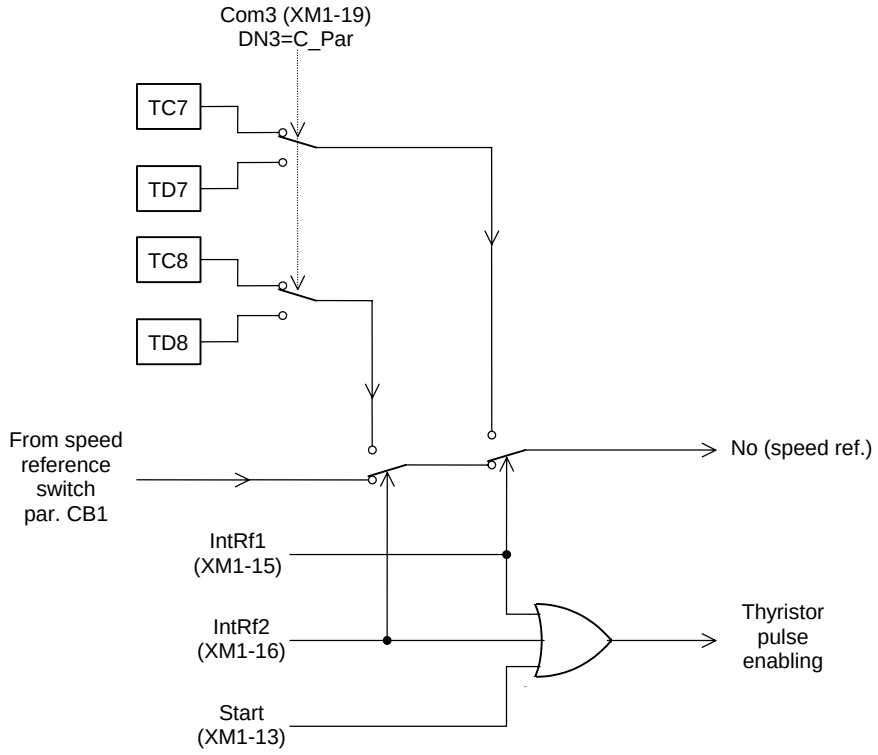
It is possible to set the ramp time, in seconds, of the motopotentiometer by the CB4 parameter.
CBE parameter set to ON enables the storage of the last reference set on CB9 parameter. In this way, the last set reference is held after a reset sequence and with the converter not powered also. To use this function, JP4 jumper must be in 1-2 position.

If the quick restart function is enabled, in the event of power loss the motopotentiometer reference is automatically stored to CB9 parameter.

CBF parameter set to ON performs the zeroing of the last set reference when speed reaches zero.

D8 Internal references (Jog)

SYSTEM CONFIGURATION



It is possible to control the internal speed references to perform a slow running function (Jog) or, however, the running with a constant reference set on a parameter. Four internal reference values are available, corresponding to the four parameters TC7, TC8, TD7 and TD8.

The internal references enable is handled through the commands INTRF1 (terminal XM1-15), INTRF2 (terminal XM1-16) and Com3 (terminal XM1-19).

Com3 active command, if parameter DN3 = C_Par, enable the references programmed by TD7 and TD8 parameters instead of those programmed by TC7 and TC8 parameters.

INTRF1 command unlocks the converter, instead of the START command (terminal XM1-13) and forces on the speed reference the value programmed by TC7 or TD7 parameters depending on the Com3 status.

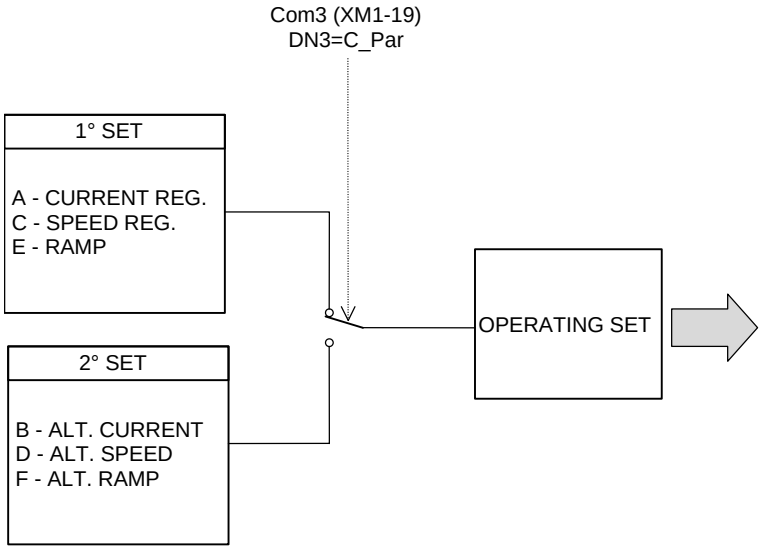
INTRF2 command unlocks the converter, instead of the START command (terminal XM1-13) and forces on the speed reference the value programmed by TC8 or TD8 parameters depending on the Com3 status.

INTRF1 command has a higher priority than the INTRF2 command and the START command.
INTRF2 command has a higher priority than the START command.

If CB2 parameter is set with the IntRef value, enabling the terminals XM1-15 and XM1-16 the values programmed by TC7, TC8 or TD7 and TD8 parameters are added and not substituted to the present speed reference.

D9 Changeable parameters

SYSTEM CONFIGURATION



The regulation parameters related to the current regulator, to the speed regulator and to the ramp handling can be programmed in a double set.
The change from one set to another occurs by Com3 logic command (terminal XM1-19), allowing the use of a converter to drive two motors having different characteristics in the same application.

The changeable parameters are listed in the TUNING PARAMETERS and subdivided into the following groups:

1st SET	2nd SET
A - CURRENT REG.	B - ALT. CURRENT
C - SPEED REG.	D - ALT. SPEED
E – RAMP	F - ALT. RAMP

DN3 parameter must be programmed as C_Par.

When Com3 logic command (terminal XM1-19) is active, the 2nd set parameters are enabled, when not active the 1st set parameters are enabled.

D10 Field reversing

The function field inversion is used in the applications in which it is required a bidirectonal regenerative operation from a motor in c.c. supplied with an unidirectional converter SILCOPAC D (in short. SPDM).
Differently from what occurs when using a reversible converter the torque inversion is managed by operating on the field current instead of on the armature current. The constant of time of the field circuit is much more greater than that of the armature current of the motor for which the whole phase of inversion may require a relatively long time, that limits the applications of this function to the only cases in which it is not necessary a high dynamics of the torque inversions.

D10.1 Parameters

The following list includes all parameters concerning the SPDM...U mentioned in the description of the function "field inversion".

DA2 = Unid.	The function *field inversion* cannot be enabled if the converter is reversible. Therefore, before enabling the function it is necessary to configure the parameter DA2 as 'Unid'.
DM2 = Ifo	The function *field inversion* cannot be enabled if before the analog output PWM2 (terminal XM1-39) has not been configured to provide the reference of current of field. Therefore, before enabling the function you must configure the parameter DM2 as 'Ifo' (value of default).
CCA = ON	Enabling of the regulator of the electromotive force;
CCB = ON	Enabling of the function field inversion;
CA8	Threshold of intervention of the function field inversion. The procedure of field inversion starts as soon as the current reference Ia0 coming from the speed regulator (or from another source which can be established with the parameter CA1) changes the sign and in absolute value exceeds the threshold which was set with the parameter CA8.
CC1	Field saving. The field current of the motor is reduced at the value programmed in CC1. The reduction of the field current occurs only if the status of the converter is SUPPRESSION or PROTECTION. Furthermore the start of the reduction of current occurs after a programmable delay with the parameter CC3 from the instant of passage from the status of REGULATION to the status of SUPPRESSION/PROTECTION.
CC3	Intervention time of of the "field saving" function expressed in software cycles. The corresponding delay, in seconds, is worth CC3·CD3.
CC2	Delay time of the enabling of the impulses to the thyristors at the end of the field inversion expressed in software cycles. The corresponding delay, expressed in seconds, is worth CC2·CD3.

The figure D10.1 shows the configuration with single motor made of an unidirectional SPDM and a reversible exciter SPDME.

The reference *If*0 and the feedback of field current *If* are exchanged between SPDM and SPDME through the available analog inputs and outputs on terminal board XM1.

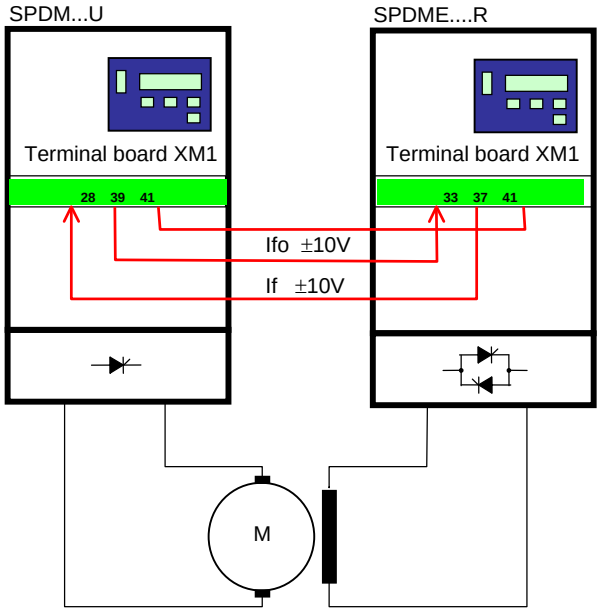


Figure D10.1 Configuration with single motor

D10.2 Functions description

In figure D10.2 it is represented the simplified diagram for the regulation of the motor speed.
The procedure of field inversion starts as soon as the reference of current Ia0 -coming from the speed regulator or another source which can be established with the parameter CA1- change its sign and exceeds in absolute value the threshold which was set with the parameter CA8.
During the whole inversion the firing pulses of the thyristors of the armature bridge are generated with limit delay (165°) and the regulator of current remains disabled.
The procedure ends when there are at the same time the following three conditions:

1. the current of field If has the same sign of the reference If0;
2. there has been an end to the conditions of intervention of the protection *lack of field and transducer of armature voltage malfunctioning* (see description of the parameters DCF, DC3, and DCE);
3. The difference between the reference If0.of the current of field and the reaction If is lower than 50%.

At the end of the procedure of inversion, the activation of the current regulator may be delayed if you wish to allow to the current of field to reach its new operating value.

The parameter CC2 allows to obtain such delay in terms of software cycles. The corresponding time may be calculated with the formula:

time of delay = CC2·CD3 [s] where CD3 is a parameter which may be 10, 5 or 3.3 ms.

For example, if CD3=10 ms and CC2 = 20 then the delay time is worth CD3·CC2 = 200ms.
During the field inversion the current regulator of the SPDM remains disabled; this involves that, at the moment of unlock of the regulator, the speed of the motor and the reference of speed can be very different and as a consequence you may have a high request of current made by the speed regulator, with possible negative consequences on the mechanics. The function *field inversion*, if used with the ramp enabled (terminal XM1-14), allows to obtain a soft transaction ("bumpless") at the moment of the unlock of the current regulator.
In the moment of the unlock, the function equalizes the operating reference of speed (N0) to the feedback of speed (N) and sets to zero the integrator internal to the speed regulator. Subsequently, the operating reference of speed N0 is changed linearly, through the ramp function, from the value N up to a speed reference value existing upstream the ramp. In this way the request of current Ia0Nrg made by the speed regulator does not undergo a sudden increase, but gets a gradual evolution determined by the slope of the ramp.

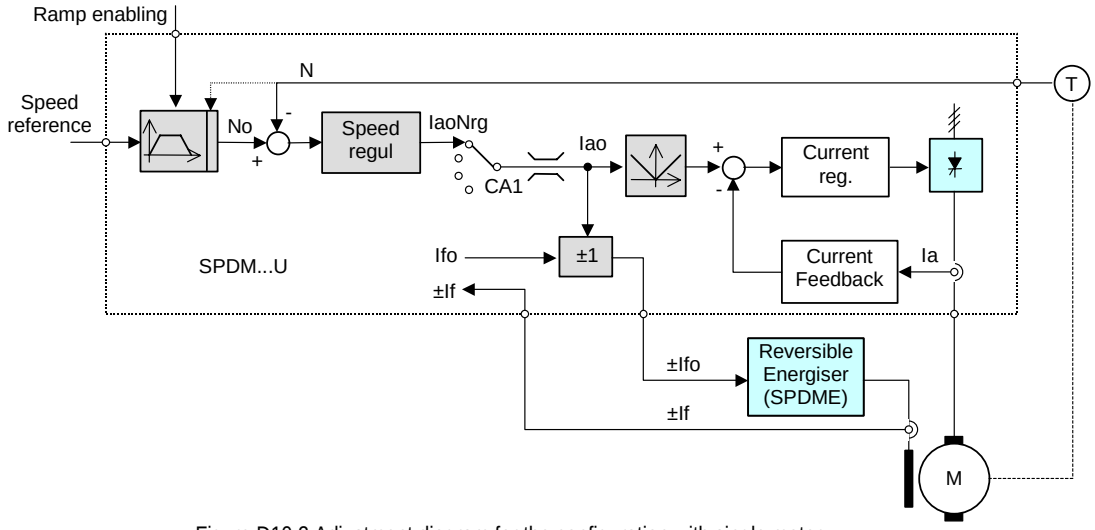


Figure D10.2 Adjustment diagram for the configuration with single motor

Upon startup, the motor starts immediately to turn in the direction required if the field has the correct direction; however, if the field has not a correct direction, the speed regulator control the inversion and maintains the system in a status of wait. until the procedure of inversion is achieved. The waiting time of the completion of the inversion may represent a problem, especially in the repeated startup and stop maneuvers in the two directions of run (maneuvers of jog, for example).
This waiting time is shortened if, after the stop of the motor, the field is lowered to a minimum value through he function *field saving*, which reduces the intensity of the field to the value pre-established with the parameter CC1. After the stop of the motor, furthermore, the reduction of the field might be delayed for a time which can be set from 1 to 9999 software cycles through the parameter CC3.
The corresponding delay expressed in seconds is:

time of delay = CC3·CD3 [s].

If during the procedure of inversion of the field, the speed regulator requires a further inversion, it is immediately operated with no need to await that the first inversion is achieved.

The field current feedback is acquired on the dedicated analog input If (terminal XM1-28, mass on XM1-41; ±10V; JP25 closed on pin 1 and 2).
The *inversed tachometer* protection is not activated when it is enabled the function of field inversion.

D10.3 Signalings and diagnostic

For the signalling purposes, two of the six logic outputs available in the SPDM can be configured to indicate the direction of the field and the status of the converter concerning the phase of the field inversion.
The two logic outputs chosen, OUT*x* -& OUT*y* , must be respectively configured as 'FLdIn+' and 'FldIn-' through the parameters DO*x* and DO*y*.
The table D10.1 shows the status of the two logic outputs according to the status of the converter.

OUT *x* DO*x* = FldIn+	OUT *y* DO*y* = FldIn-	Status of the converter
0	0	The converter is in status of protection and/or suppression. Direction of the field is undefined.
0	1	Converter not in phase of field inversion. The field has positive direction.
1	0	Converter not in phase of field inversion. The field has negative direction.
1	1	Converter in phase of inversion.

Table D10.1: Status of the two logic outputs according to the status of the converter.

In the table the indexes *x* and *y* refer to one of the six logic outputs of which the output OUT1 and the output OUT2 are available on the terminal board XM1 of the SPDM and the remaining outputs OUT3, OUT4, OUT5 and OUT6 are available on the expansion SPDIO1.
The reference of current on the output of the speed regulator IaoNrg, indicated in the diagram of figure 6.2, can be displayed on the display of the keypad, or converted in analog form, by suitably configuring the parameters DG5, DG6 or DG7 and the parameters DM1, DM2 and DM3

Example:

DG5 = IaoNrg	The auxiliary variable AUX1 assumes the meaning of "Reference of current generated by the speed regulator".
DM1 = Aux1	The auxiliary variable AUX1 is converted in analog form at the output PWM1 (terminal XM1-37).

D11 Quick restart

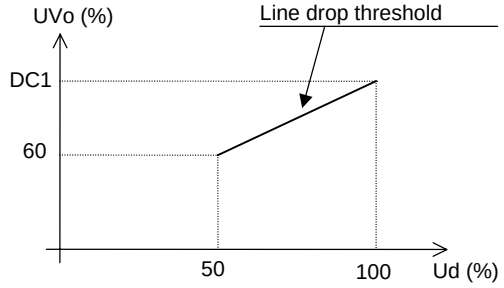
The quick restart function handles the intervention conditions of the "Line Loss" and "Line beyond tolerance" protections, avoiding the storage of the lock status. In this way the system restart is allowed at the return of the normal operating conditions, without the intervention of the user and avoiding the machine stop.
If the speed reference is obtained by means of the motor potentiometer, if there is no supply mains, it is automatically stored in the CB9 parameter so as to be reused during the restarting.
The function is enabled by setting the parameter CDB QuickS = ON.

More precisely the function is referred to the following definitions:

- Line loss: it is a supply voltage (terminal block XM2) drop under a fixed threshold equal to 50% of the main voltage, of at least 5ms duration.

- Line Drop: it is a falling of the supply voltage (terminal block XM2) under a programmable threshold (Uv_{0Min}), with duration greater then 20ms. The threshold value equals the 60% of the nominal line voltage, if the armature voltage is in the range 0 to 50% of the nominal voltage; if the armature voltage is higher than 50%, the threshold value can be determined by to the following formula:

$$U_{VoMin} = 60\% + \frac{(Ud - 50\%) \cdot (DC1 - 60\%)}{50\%}$$



where:

Uv_{0Min} = is the threshold operating value for the line drop intervention (percentage value of the nominal supply voltage, DB1 parameter).
DC1 = is the minimum threshold parameter for the line beyond tolerance protection intervention.
Ud= is the armature voltage as percentage of the nominal voltage (DB4 parameter).

When the function is enabled, if a line loss or a line drop occur, the system will begin the following sequence:

- It goes into protection status displaying this condition on the user interface and doesn't execute the storage procedure of the first occurred protection (items 1.1 and 1.2, Section C of this Manual).

- When the supply voltage returns to normal value, the system executes a bumpless restart of the machine.

- If the line loss or the line drop have a duration less than 100ms, the control circuits of the converter remain properly powered and synchronized with the supply line, allowing an instant restart; if the line loss or the line drop have a duration greater than 100ms, during the restart phase (true system power-on) some tests on the circuits and the line re-synchronization is executed, adding about a 500ms delay.

D12 Speed error

This function is used in hoisting applications, where is necessary to keep under control the speed regulator. A logic output (OUT1, OUT2, OUT3, OUT4, OU5 and OUT6) is activated when the absolute value of speed error (Speed ref. - Speed feedback) is higher than a programmable value and this condition lasts for a programmable interval.

PARAMETERS:

CF7 Max permissible value of speed error.

CF8 Time (tenth of milliseconds) in which speed error must be higher than CF7, to set a logical output.

DO1 - DO6 Set one of parameters (from DO1 to DO6) to "NRegEr" to have the relative logic output enabled if the condition described above (CF8) is true.

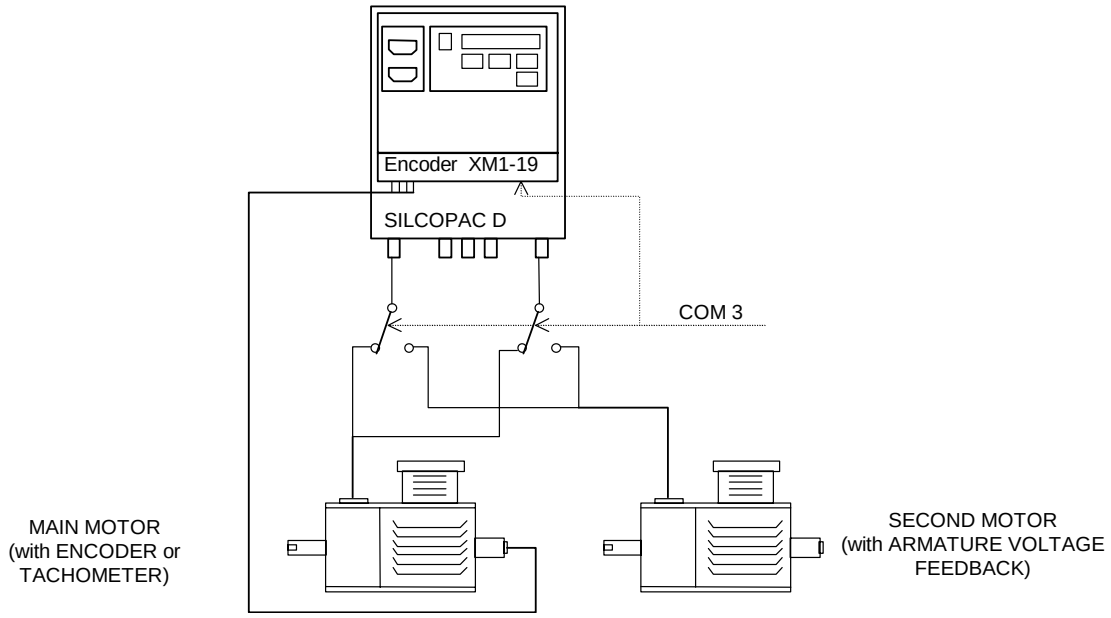
Speed error is calculated after ramp.

If the absolute value of speed error becomes again lower than par CF7, the corresponding logic output is disabled.

D13 COM3 speed feedback switching

The function is normally used in applications where two motors are used (ex. cranes); the first motor speed feedback comes from a tachometer or from an encoder; the second motor speed feedback is calculated from the armature voltage.

The switch from one speed feedback source to the other one must be carried out only when motors are still.
The armature voltage feedback motor must always work in the constant torque range (full flux).
In addition, the armature voltage feedback motor flux can be set through CC4 parameter.



PARAMETERS:

CFF	FUd_C3	Function enable.
DN3	Com3S	Must be programmed with the value C_Par.
CC4	FLXmn	Motor flow when it reacts in armature voltage
TUNING PAR.	Groups: A - B - C - D - E - F; parameters in the alternative sets must be correctly programmed because the function activates parameter switching too.	

DESCRIPTION:

When COM3 input is OFF the speed feedback is acquired from the source selected by CB3 parameter; A - C - E groups of TUNING PAR. are active; the motor can word also in the weakened field range and base speed (percentage of max. speed) is acquired from par. DB7.

When COM3 input is ON the speed feedback is calculated from the armature voltage (as is if par. CB3 = F(Ud). B - D - F groups of TUNING PAR. are active; the motor must work in the constant torque range (full flux) and the par. DB7 is automatically set to 100%.

COM3	Speed feedback	TUNING PARAMETERS Active changeable groups	Base speed (%)
OFF	As per par. CB3	A - C - E	as per par. DB7
ON	F(Ud)	B - D - F	100

D14 Logic Outputs

The logic outputs can be customized to signal if the field current is lower than the parameter CC4 (new parameter 'IfThr'). The signalling of current for a field lower than CC4 is obtained by programming the parameters DO1,...,DO6 (corresponding to outputs OUT1,...,OUT6) as If<CC4.
It has also been introduced the hystheresis on the signalling N>CE6. The extension of the hysteresis is established by parameter CB6.

D15 Traces

The DRIVE TRACE and the THYRISTOR TRACE can be blocked, besides by the intervention of a protection, also by the external logic input COM2. The possibility to block the two traces from the outside allows to display the status of the drive in a special moment with no need for a protection to operate. The traces, after the stop, can be printed in any moment, provided that power supply to the control is not switched off, nor a reset is made.
The function which allows the stop of the traces from COM2 is enabled with the parameter DGD 'C2Stop' (new parameter).
The traces are frosted in correspondence of the transition low→high of COM2. the restart of the traces is obtained

- by disabling the function (DGD = OFF), or
- resetting the converter, or
- passing from the status of protection/suppression to the status of regulation, independently from the status of COM2.

To know the status of the traces (activated or blocked) we must access to the menu STATUS in which a blinking dot indicates if the traces is operating; if, on the contrary, the dot is fixed, then the trace is blocked.

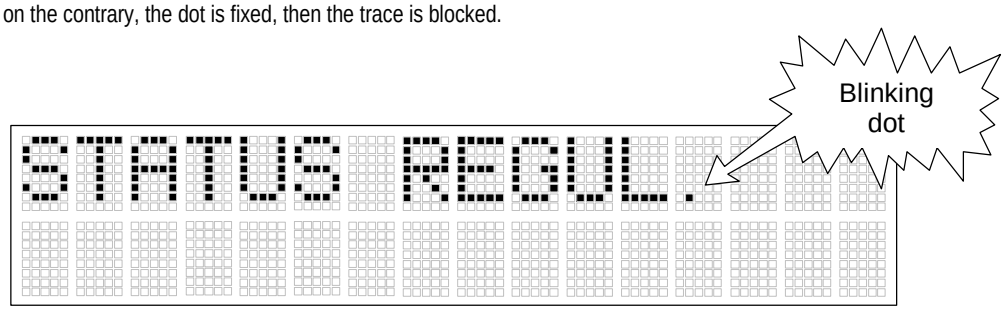


Figure D1.15

With the new parameter DGE the function 'AUTOPRINT' of the traces can be activated also in case of intervention of the external protection:
DGE = OFF the autoprint is not performed in case of external protection.
DGE = ON the autoprint is performed also in case of external protection.

D16 Diagnostic variables

The auxiliary variables Aux1, Aux2 and Aux3 can be customized to display the power provided by the axis of the motor (in % compared to the rated power).
the power to the axis is calculated as:

$$P_{axis}[\%] = \frac{U_d[\%] \cdot I_a[\%]}{100} - \frac{DB9}{100} \cdot \frac{I_a[\%] \cdot I_a[\%]}{100} - \left[CE3 + CE4 \cdot \frac{N}{100} \right]$$

The first addendum represents the electric power supplied to the motor, the second addendum represents the losses by Joule effect in the motor and the third addendum represents the losses by friction.
Definition of symbols:

Ud	Armature voltage of the motor;
Ia	Armature current of the motor;
DB9	Parameter which expressed the voltage drop on the resistance of the windings of the motor at the rating current of the converter. The value is expressed in % of the rating voltage of the motor;
CE3	Parameter which contains the value of the power lost, due to the constant frictions, expressed as % of the rating power;
CE4	Parameter which contains the value of the power lost, due to the variable frictions with the speed, as % of the rating power;
N	Speed of the motor, expressed as % of the maximum speed.

To display the power provided to the axis, schedule the parameter DG5 (or DG6 o DG7) as 'MecPow'.

D17 Double set complete of parameters

It is possible, with this function, to store in memory two complete set of parameters, the function it enabled by setting the parameter CDG=ON. The double set of parameters can be useful, for example, to have two different configurations of the adjusters, as in the typical case of a winder whose configuration must be changed according to the material wound up:

- Tension regulation with control of the current limit (configuration 3 of the manual SPDM);
- Tension regulation with control of the speed reference and calculation of angular speed (configuration 1 of the manual SPDM)

The passage from the first to the second set is made during the reset of the converter and the set of parameters is established by input COM1.

During the reset	if COM1 = OFF	⇒	first set
	if COM1 = ON	⇒	second set

The eventual function assigned to COM1 (e.g. the motopotentiometer) is suspended during the procedure of change.

The sequence of commands to obtain the change of the set, graphically illustrated in figure 5.1, is as follows:

1) disable the converter opening the terminal XM1 - 20 (External protection) (instant T1);
2) put COM1 according to the desired set (instant T2);
3) reset the converter (supply XM1-21 Reset for at least 0.2 sec) (instant T3);
4) upon the release of the reset (instant T4), COM1 it must remain in the position which was set in (2) for at least 1 sec, i.e. the time necessary for the check to end the procedure of reset. At the end of the procedure of reset, the converter SPDM assumes the set of parameters corresponding to the position of COM1 (OFF⇒1° set, ON⇒2° set);
5) bring back COM1 to the original status (instant T5);
6) enable the converter by power supplying the terminal XM1 - 20 (External protection) (instant T6);

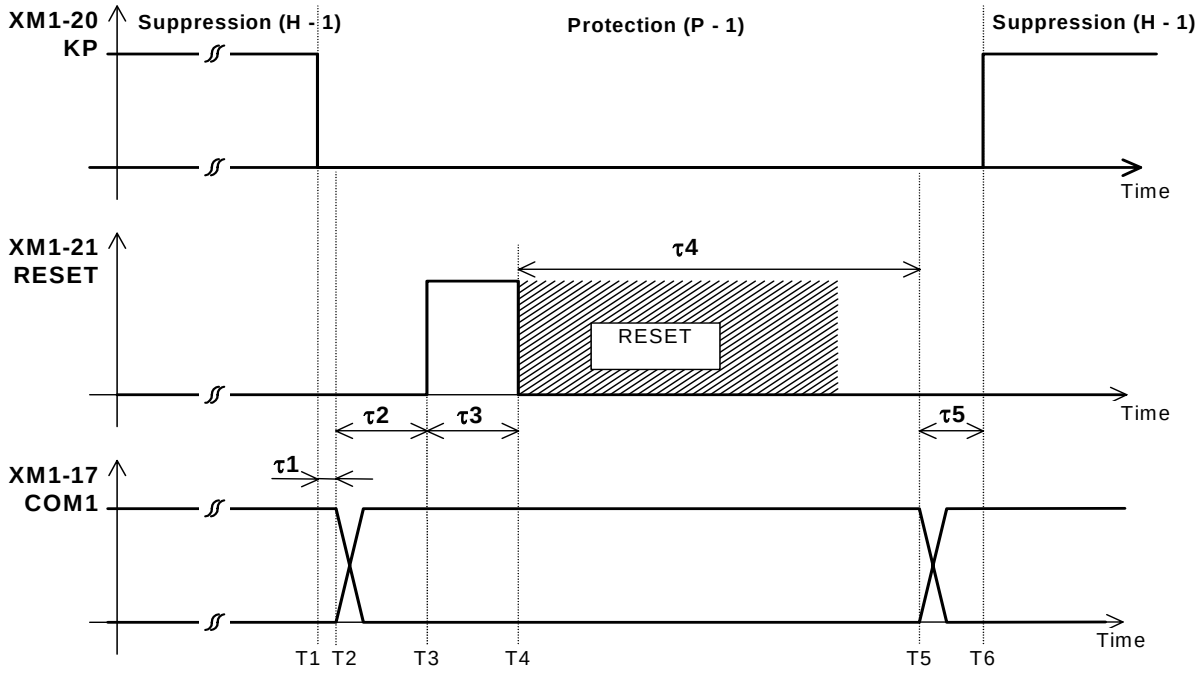


Figure D17.1

τ1: delay from the instant of passage in protection to the instant of commutation of input COM1 (≥ 0 s);
τ2: delay from the commutation of COM1 to the application of the impulse of reset (≥ 0 s);
τ3: duration of the impulse of reset (≥ 0.2 s);
τ4: delay from the instant of end of the impulse of reset to the instant of reset of COM1 to its original meaning. This delay must be greater than the time employed by the check to end the reset procedure (≥ 1 s);
τ5: delay from the instant of commutation of COM1 to the passage to suppression. COM1 must regain the original function before the return to the status of suppression.

It is possibile to know the active parameters set by proper programming a logic output.

WARNING If the function is enabled, in order to avoid dangerous situations it advisable to verify the active parameters set before to start the equipment .



As an example, we indicate in figure D1.14.2 a possible diagram of connection of input COM1.

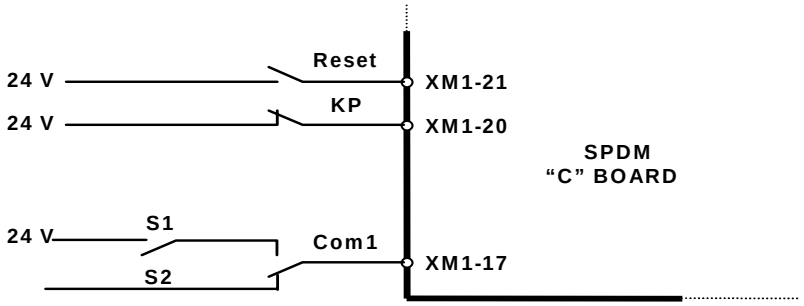


Figure D17.2

The switch S1 preselects the set of parameters to enable upon the reset (S1 open ⇒ set 1; S1 closed ⇒ set 2). On the instant T2 the selector S2 switch the input Com1 on the signal coming from S1 and on the instant T5 it restores the original function of input Com1 (for example for motopotentiometer).

During the change of the parameters from the keyboard it is possible to recognize the set in which you are operating thanks to the indication (1) or (2) which appears near the message SELECT GROUP.
It is also possible to display the current selection through one of the logic outputs, for example OUT1 XM1-24 configuring it with the value ParSet (new).
It is also possible to read through the serial interface the current selection at the address 246.

At the first power up (or reset) with COM1 = ON, the software initializes the parameters of the second set, as if it recognizes a new EEPROM (Test 5, see manual section C, par. 1.1).

D18 "BUMPLESS" function.

The "Bumpless" function is used when the drive must start with a spinning motor.

The drive first detects the actual motor speed then it resumes control of the motor and accelerates it from the restart speed to the set value of speed reference.

The previous release the control started from zero speed reference conseguently sharp braking occurred.
The function is always enabled, it does not need any setting but it needs the ramp function.

D19 Rampa di emergenza.

In order to avoid sharp braking, a ramp with time programmable (TH3=TacRF, th4=TdcRF -0-999,9s) for emergency stop is available.
For the operation see the block diagram (Appendix D- F3).

D20 Regenaritive braking disable.

The function, effective with four quadrant converters, allows to avoid the fuses breaking in some applications in which for different causes (excessive reduction of the power supply voltage...) it has no been possible to keep the proper margin between the power supply voltage and the armature voltage.

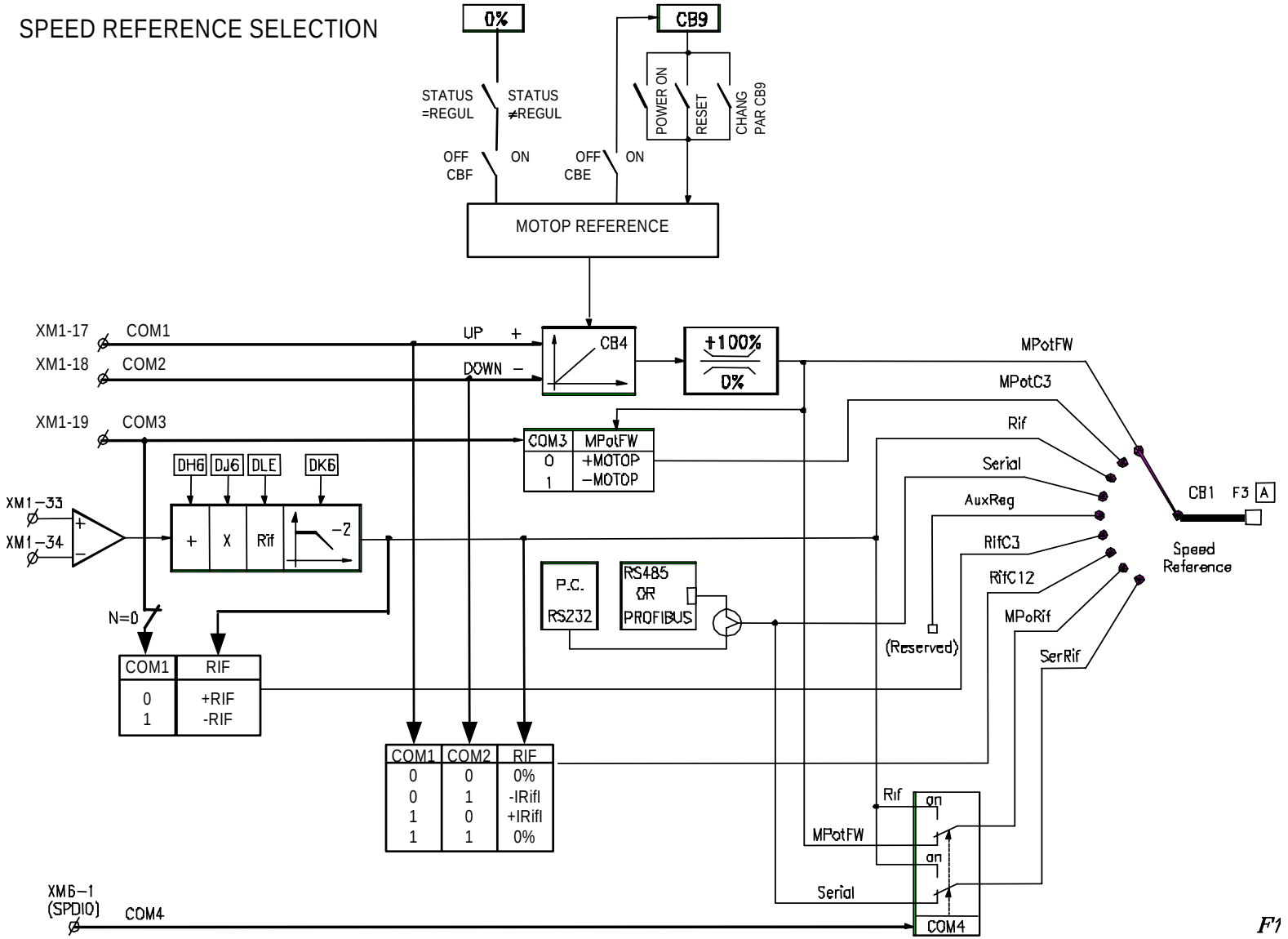
The function disable the regenerative braking if the armature voltage is greater than a programmable threshold value.

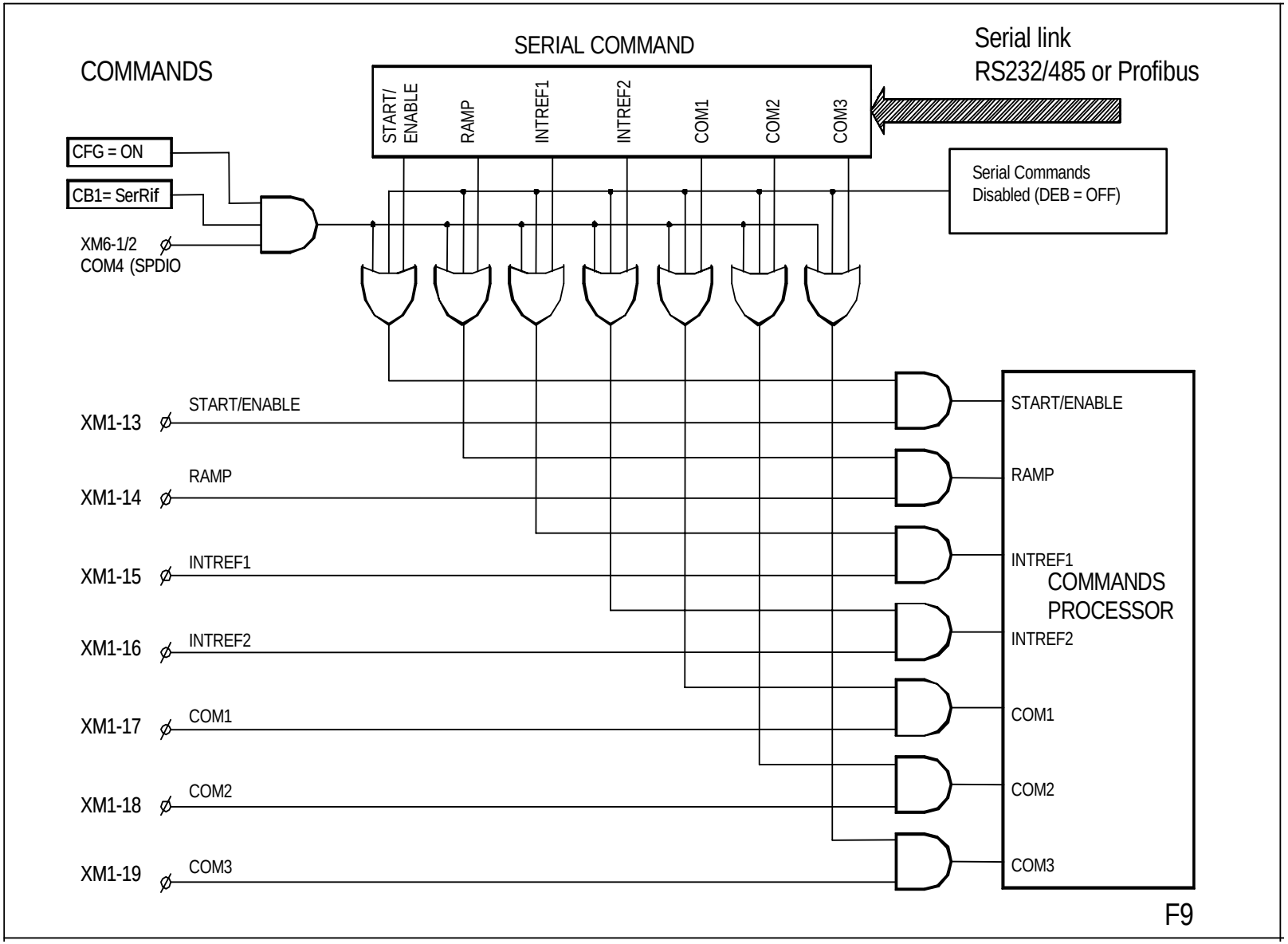
It is possible to enable the function by the parameter CEC (CEC= Dis Reg = ON/OFF) and to set the threshold by the parameter CE2 (Output voltage threshold: if the armature voltage value is greater than the threshold value the regenerative braking is disabled).
If the armature voltage decreases below the value equivalent to the threshold value the regenerative braking is enabled.

D21 Toggling of the references and commands

The selection of the origin of reference of speed (parameter CB1) foresees two new possibilities: 'MPoRif' and 'SerRif'.
The first one allows to toggle the speed reference from Motopotentiometer to terminal board (input Ref XM1-33, XM1-34) and the contrary; the second one commutes the reference from serial line to input 'Rif'.
In both cases, the commutation is performed through the logic input COM4 (terminal XM6-1, XM6-2, expansion card I/O SPDIO).

CB1 = MPoRif	(New) The speed reference comes from the motopotentiometer when the input COM4 is OFF. If COM4 is brought to ON the speed reference is read by the analog input 'Rif'.
CB1 = SerRif	(New) The speed reference comes from the serial line when the input COM4 is OFF. If COM4 is brought to ON the speed reference is read by the analog input 'Rif'; in this case the protection of serial loss is automatically masked.
CFG = ON	(New) This parameter enables the function of exchange of the commands (Start, Ramp, IntRef1, IntRef2, Com1, Com2, Com3) from serial to terminal board through the logic input COM4. This function is activated only if CB1 is programmed as SerRif, in this way the commands and the references can be simultaneously toggled from serial to terminal board through the only command COM4. COM4 = OFF commands from serial line (if DEB = ON). COM4 = ON commands from terminal board


SPEED REFERENCE SELECTION
0%
CB9
STATUS =REGUL
STATUS ≠REGUL
POWER ON
RESET
CHANG PAR CB9
OFF CBF
ON
OFF CBE
ON
MOTOP REFERENCE
XM1-17 COM1
XM1-18 COM2
XM1-19 COM3
UP +
DOWN –
CB4
+100%
0%
MPotFW
MPotC3
Rif
Serial
AuxReg
RifC3
RifC12
MPoRif
SerRif
CB1 F3 A
Speed Reference
COM3 MPotFW
0 +MOTOP
1 –MOTOP
DH6 DJ6 DLE DK6
XM1–33
XM1–34
+ X Rif –Z
N=0
P.C. RS232
RS485 OR PROFIBUS
(Reserved)
COM1 RIF
0 +RIF
1 -RIF
COM1 COM2 RIF
0 0 0%
0 1 -|Rif|
1 0 +|Rif|
1 1 0%
Rif
MPotFW
Serial
gn
gn
COM4
XM6–1 (SPDI0)
COM4
F1


COMMANDS
SERIAL COMMAND
Serial link
RS232/485 or Profibus
START/ ENABLE
RAMP
INTREF1
INTREF2
COM1
COM2
COM3
CFG = ON
CB1= SerRif
XM6-1/2
COM4 (SPDIO
Serial Commands
Disabled (DEB = OFF)
XM1-13
START/ENABLE
XM1-14
RAMP
XM1-15
INTREF1
XM1-16
INTREF2
XM1-17
COM1
XM1-18
COM2
XM1-19
COM3
START/ENABLE
RAMP
INTREF1
COMMANDS
PROCESSOR
INTREF2
COM1
COM2
COM3
F9

E ENHANCED FUNCTIONS

E0 Software release

The enhanced functions must be enabled and configured by appropriate parameters, grouped by their function in Configuration and Tuning Parameters.
Some of these functions are incompatible each one to other because they use the same system resources. For the same reason the enhanced functions may be incompatible with some of the auxiliary functions.
Any attempts to contemporary enable the auxiliary and/or enhanced functions, incompatible each one to other, fail and result in the CONSISTENCY ERROR message on the display (parameters consistency error).

The using of some enhanced functions implies a proper configuration of the converter hardware (applications of some options and/or specific machine equipment) that will be discussed in the setting up procedure description of the function itself.

E1 ANGULAR POSITION REGULATOR

The function is used to perform the angular positioning of the motor shaft in respect to a position reference set by a parameter (two distinct references as function of the motor rotation direction).

E1.1 Required hardware

The motor must be equipped with an Encoder.
The zero pulse can be generated by the encoder itself (three channels Encoder) or it can be independently generated.

E1.2 Parameters setting

CB3 = Encod	Speed feedback from the Encoder.
CBD = ON	Ramp command bypass enable.
CGA = ON	Function enable.
CGB	Set to ON if the converter suppression status is required after the positioning. Set to OFF if the continuous converter regulation is required even after the positioning.
CG2	Set to the absolute value of the approaching speed (percent value of the speed full scale: DB5 parameter).
CG3	Set to forward angular position reference value (indicated as Encoder pulses number).
CG4	Set to reverse angular position reference value (indicated as Encoder pulses number).
CG1	It is a multiplying coefficient of parameters CG3 and CG4. If the set value is not zero, then the position reference is re-calibrated according to the following formula: $RifP = RifP \bullet CG1$ where RifP = position reference CG3 for positive rotation direction; CG4 for negative rotation direction.
CG5	Set to the maximum allowable position error value (Encoder pulses number). If the position error is lower than the value set by this parameter, the system will go in State = "Positioning completed" (see CGB parameter).
TJ1	Set to the proportional gain value of the position regulator.
TJ2	Set to the value which the speed regulator proportional gain must assume after the positioning (only if CGB = OFF).
TJ3	Set to the value which the speed regulator integral gain must assume after the positioning (only if CGB = OFF).
TJ4	Set to the value which the speed regulator derivative gain must assume after the positioning (only if CGB = OFF).
DO1 - DO6	It is possible to program each one of parameters DO1 to DO6 with the value "ErrP = 0": the relevant logic output (OUT1 - OUT6) will be active when the position error will be lower than the value set by CG5 parameter (after the positioning).

E1.3 Logic commands

COM2 Terminal XM1-18.
If enabled, the positioning will be reached.
If disabled, the motor is speed regulated.

E1.4 Function description

When COM2 command is disabled, the angular position regulator is excluded and the motor will be speed regulated.

When COM2 command become enabled, the converter will reach the approaching speed, which sign depends on the rotation direction that the motor had when COM2 was enabled.

When the approaching speed will be reached and kept for 200msec min time, the zero pulse acquisition phase will begin. The position reference is chosen among the two parameters CG3 and CG4 depending on the motor rotation direction (CG3 if forward speed; CG4 if reverse speed).
If the gear ratio of the motor is 1:1 and the same position is required both in forward and reverse speed conditions, set CG4 parameter according to the following formula:

CG4 = DB8 - CG3 where: DB8 = Encoder pulses number / turn ratio.

When the position error absolute value is lower than the value set by CG5 parameter, the motor is stopped and the positioning ends.

If CGB parameter is set to ON, after the positioning the converter will go in suppression status; on the seven segments display the following symbols will appear:

H - 3 alternatively blinking

and using the Status function, the display shows the message:

STATUS SUPPR.
Disable Opt. Fun.

If CGB parameter is set to OFF, at the end of the positioning the converter continues to hold the motor position and the proportional, integral and derivative gains set by parameters TJ2, TJ3 and TJ4 respectively will be imposed to the speed regulator.
When different gains than those set for the normal operating conditions are not requested to be imposed to the speed regulator, set parameters TJ2, TJ3 and TJ4 to the same values programmed on parameters TC1, TC2 and TC3 respectively (TJ2 = TC1, TJ3 = TC2 and TJ4 = TC5).

E2 INERTIA COMPENSATION

The function is normally used in speed regulated systems where the motor drives a very inertial load. When a speed variation has to be impressed to these systems, the machine inertia must be compensated introducing a summing term to the current reference which depends on the speed variation itself.

E2.1 Parameters setting

CMA = ON Function enable.
CM1 = Const. Calculation of the term for the inertia compensation as function of the speed variations.
CM6 Set to the machine acceleration time value (as seconds).

E2.2 Measure of the machine acceleration time

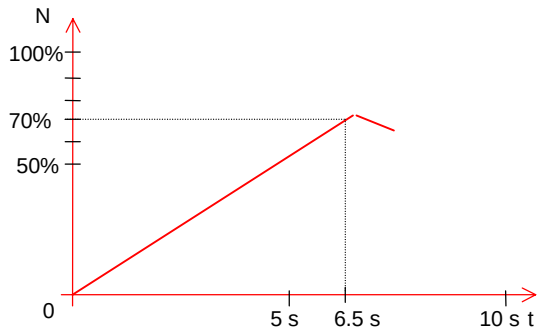
It is defined as machine acceleration time the period which the motor takes to reach the basic speed starting from zero speed, when it operates at the nominal armature current.
It can be measured according to the following sequence:

- set DM3 parameter to N value to configure the Pwm3 logic output as signal proportional to the speed (default value) (par. 8.3.2).
- connect a scope to Pwm3 logic output (terminals XM1-40, 41)
- set scope to 2V/div
- set a scope timebase adequate to display the complete phenomena (e.g. 2-5 s/div)
- set DC4 parameter to the value programmed on DB7 parameter
- by SETUP REFERENCE function set an armature current reference (FIXED) equal to the value set for the DB6 parameter (nominal motor current)
- enabling the converter (Start command), the motor accelerates until the max speed protection occurs (P - B)
- store the waveform on the scope and measure the time between zero speed and basic speed (remember that 10V voltage value at the analog output means maximum speed (100%)
- restore the normal conditions and reset the converter.

Example:

Max speed = 1000 rpm
basic speed = 700 rpm
max current = 30A
nominal current = 20A

DC4 = DB7 = 700 / 1000 • 100 = 70%
DB6 = 20 / 30 • 100 = 66.6% (curr. ref. set in Setup Reference)



Note 1: it is possible to measure the acceleration time at a current reference equal to a fraction of the basic speed, multiplying later the time as read on the scope for the same fraction;
example: curr. ref. = 1/2 • 66.6% = 33.3%
t = 13s • 1/2 = 6.5s

Note 2: it is possible to measure the acceleration time stopping at a speed which is a fraction of the basic speed, multiplying later the time as read on the scope for the inverse of the same fraction;
example: speed = 70% • 1/2 = 35%
t = 3.25s • 2/1 = 6.5s

E3 BACK-LASH COMPENSATION

The function is used to null the opening effect of the back-lash that occurs during the reverse phase of the armature current. The compensation is obtained reducing the current value (torque on the motor shaft), at the end of the bridge reversing sequence, during a sufficiently long time and at a sufficiently low value to allow the back-lash recovery avoiding the rebounds. At the end of this phase, the current limits are restored to their original values through a ramp which duration can be programmed.

E3.1 Parameters setting

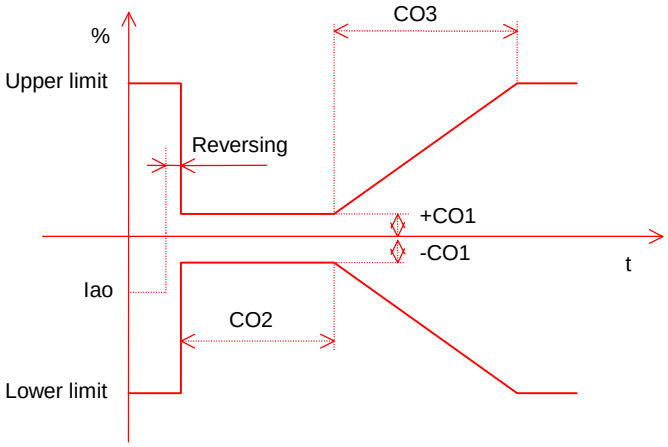
COA Set to ON to enable the function.

CO1 Set to the value at which the current limits have to be reduced (each one with its own sign) during the time set by CO2 parameter after the reversing phase.

CO2 Set to the time during which the current limits have to be reduced after the bridge reversing sequence.

CO3 Ramp duration according which the current limits change from the value set by CO1 parameter (each one with its own sign) to the original value at the end of the time period set by CO2 parameter.

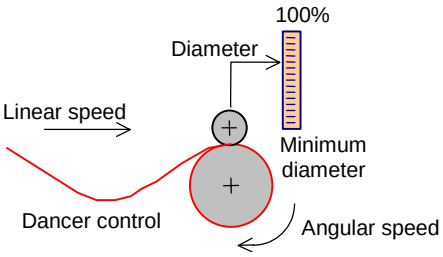
Note: The values of CO1, CO2 and CO3 must be chosen in an experimental way for the back-lash recovery, at the end of the current reversing phase, so that no rebounds or temporary instability effects on the current and/or on the speed take place.



E4 ANGULAR SPEED AS FUNCTION OF THE DIAMETER (ADP)

The function is used in those applications where, given a linear speed and acquired the diameter as analog signal, the motor has to be speed regulated changing the linear speed reference to angular speed reference evaluated as function of the diameter, so that the peripheral speed will have a constant value which do not depend on diameter variations.

A typical application, e.g., is a speed regulated winder with dancer control:



E4.1 Required hardware

The diameter transducer device must generate a 0-10V analog signal to be connected to Ean1 or Ean2 analog input (terminals XM1-29, 31 and XM1-30, 31); a signal equal to 0V means minimum diameter (set by CN1 parameter); a signal equal to 10V means maximum diameter (100%).

E4.2 Function calibration

The function calibration has to be performed according to the following sequence:

a) set CBH parameter to OFF.

b) connect to the coiler-uncoiler spindle the minimum diameter coil.

c) check that in these conditions the diameter transducer have null output.

d) connect to the spindle the maximum diameter coil.

e) check that in these conditions the diameter transducer have 10V output.

f) remove the maximum diameter coil.

g) set, through the Setup Reference - Continuous Speed Ref. function, a 100% angular speed reference.

h) check that in these conditions (minimum diameter and maximum angular speed) the linear speed, measured on the minimum diameter spindle, equal the maximum line speed (equivalent to 100% of the value shown by the Instrument Mode function at the No item).

i) if the a.m. conditions is not true, perform the calibration acting on CB8 parameter (if CB3 = Encod) or acting on DJ1 parameter (if CB3 = Tach) until the proper linear speed value will be reached.

E4.3 Parameters setting

CN6 Set to Ean1 value if the diameter transducer was connected to terminals XM1-29, 31.
Set to Ean2 value if the diameter transducer was connected to terminals XM1-30, 31.

CN1 Set to minimum diameter value (as percent of the maximum diameter).

CN2 Set to P_CN3 value if the initial diameter is acquired from CN3 parameter.
Set to Ean1 value if the initial diameter is acquired from an analog signal (0-10V) connected to terminals XM1-29, 31.
Set to Ean2 value if the initial diameter is acquired from an analog signal (0-10V) connected to terminals XM1-30, 31.

CN3 Set to initial diameter value (as percent of the maximum diameter) only if parameter CN2 = P_CN3.

CN5 Set to the time value (as seconds) taken by the diameter signal to change from the minimum to the maximum value (100%) if the line speed assumes the maximum value (100%).

CL3 Set to Wind value if the diameter assumes increasing value (winder reel).
Set to Unwind value if the diameter assumes decreasing value (un-winder reel).

CBH Set to ON to enable the function.

E4.4 Diameter acquisition logic

The signal provided by the diameter transducer is acquired reading the voltage value at the proper analog input (CN6 parameter). At 0V value the diameter has the minimum value (CN1 parameter).
At 10V value the diameter has the maximum value (100%). Remember that it is possible to perform the proper recalibrations of the voltage value at the analog input, setting the parameters DH3, DH4, DJ3, DJ4, DK3, DK4, DLC, DLD.

The diameter variations are limited by a ramp which duration can be set by CN5 parameter.

If CL3 parameter is set to Wind, the diameter can take only increasing values; diameter values lower than the last acquired one will be ignored.
If CL3 parameter is set to Unwind, the diameter can take only decreasing values; diameter values greater than the last acquired one will be ignored.
Setting one of the logic output (DO1 to DO6 parameters) to DiamErr value, if the error between the new diameter value and the last acquired one is greater than 20%, a diameter error warning will occur (the logic output changes to its active status).

E4.4.1 Logic commands

Com1 Terminal XM1-17. The rising edge of this input (transition from inactive to active command) starts a sequence that acquires through a 10s ramp, at angular speed lower than 20%, the measured diameter value bypassing the filter set by CL3 parameter and the ramp set by CN5 parameter.

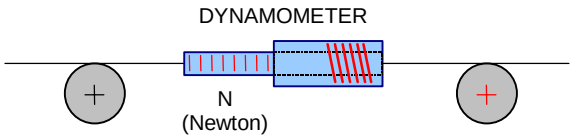
Com2 Terminal XM1-18. The rising edge of this input (transition from inactive to active command) starts the instantaneous acquisition of the initial diameter which provenience depends on CN2 setting. If CN2 is set to Ean1 or Ean2, the analog signal indicating the initial diameter (e.g. potentiometer) must have 0 to 10V swing, where 0V corresponds to the value set by CN1 parameter (minimum diameter) and 10V corresponds to 100% (maximum diameter).

E4.5 Function description

The linear speed reference is changed, as function of the diameter value, to an angular speed reference that will be sent to the speed regulator.
The evaluated angular speed reference value can be displayed through the Instrument Mode function at the No item. The acquired line speed value can be displayed by an auxiliary variable setting one of DG5, DG6, and DG7 parameters to Line_N value (set the displaying of the selected aux variable through the Instrument Mode function). The acquired diameter value can be displayed by an auxiliary variable setting one of DG5, DG6 and DG7 parameters to Diam value.

E5 TENSION REGULATORS

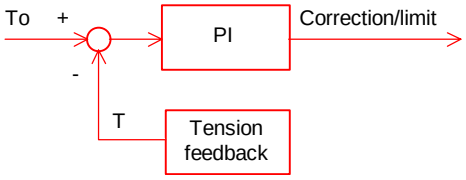
These regulators are used in those applications where a constant tension on the material is required.



The tension can be regulated by closed loop (presence of the tension feedback signal) or by open loop (calculation of the current needed to generate the torque resulting in the desired tension).

E5.1 Closed loop regulation

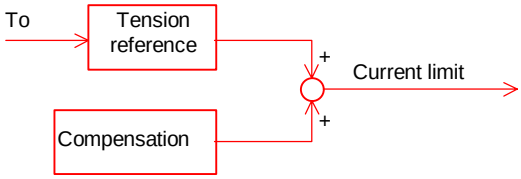
The tension reference is compared to the tension feedback; the resulting error is processed by a proportional-integral module generating a term that corrects the speed reference or that can be used as current limit (saturating the speed regulator by a term to be summed to the reference).



E5.2 Open loop regulation

In this case no comparison is performed between the reference value and its feedback, and then it is needed to calculate all terms establishing the total torque supplied to the system, e.g. the mechanical losses and the inertia effects.

The regulator generates a term used as current limit; the speed regulator is saturated by a term summed to the reference.



The "Tension reference" block defines, starting from To signal, the current needed to generate the desired tension on the material.

E5.3 Tension regulators setting

The two regulators can be both separately or contemporary used; in this last case the closed loop regulator corrects the inaccuracies of the tension generated by the open loop regulator and can be enabled or disabled in bumpless mode (CJA par.).

The following settings can be identified:

1) Tension loop with load cell; speed reference correction:

2) Tension loop with load cell; control of the current limit:

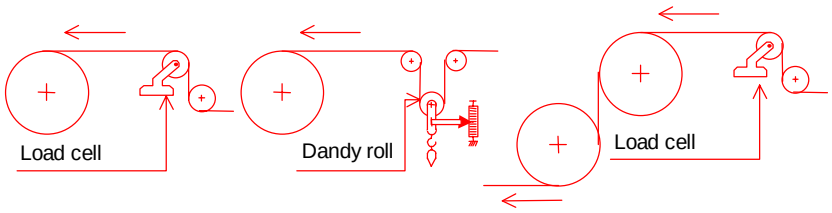
3) Axial winder; control of the current limit:

4) Tangential winder; control of the current limit:

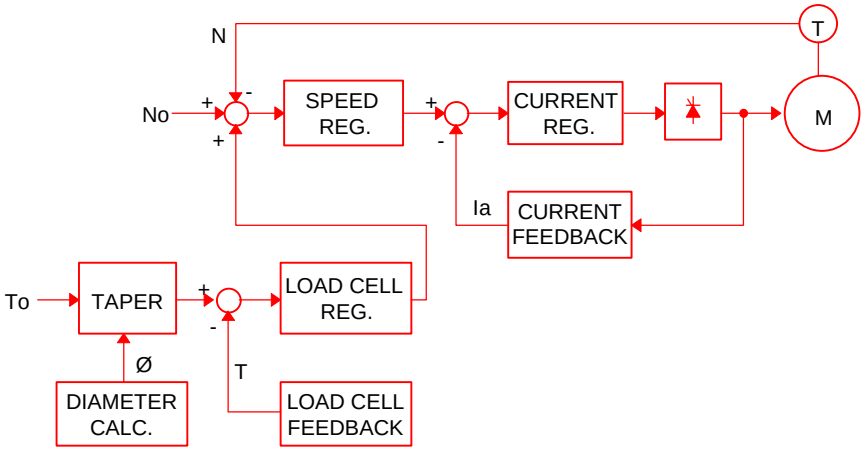
5) Axial winder + tension loop with load cell; control of the current limit:

6) Tangential winder + tension loop with load cell; control of the current limit:

E5.3.1 Setting 1 (Tension loop with load cell - correction of the speed reference)



it is a closed loop tension regulator; the tension feedback signal is provided by a transducer (e.g. load cell or dandy roll); the regulator output is used to correct the speed reference.



Blocks description:

SPEED_REG.:

Speed regulator.

CURRENT REG.:

Armature current regulator.

CURRENT FEEDBACK:

Armature current feedback (Ia).

TAPER:

Used when in the winder/unwinder applications the tension reference (To) has to be re-calibrated as function of the coil diameter. the re-calibration can be linear or hyperbolic type. When the function is disabled the tension reference is directly passed to the comparison node.

DIAMETER CALC.:

The diameter is acquired as analog signal provided by a proper external transducer.

LOAD CELL:

Transducer of the tension feedback (T) (e.g. load cell or dandy roll). The value is acquired as analog signal.

LOAD CELL REG.:

Tension regulator; it receives the tension error from the node of comparison between the tension reference and feedback and generates a term that corrects the speed reference (No).

Parameters setting Setting 1 (Tension loop with load cell - correction of the speed reference)

CJA Set to ON to enable the function.

CJ1 Set to the value according to the proper tension reference source:

- M_Pot: tension reference from software motopotentiometer (0-100%); Com1 command increases the reference value, Com2 decreases the reference value (terminals XM1-17, XM1-18).
- Rif: tension reference from Rif analog input (0-100%) (terminals XM1- 33, 34).
- Ean1: tension reference from Ean1 analog input (0-100%) (terminals XM1- 29, 31).
- P_CJ4: tension reference from CJ4 parameter (0-100%).

CJ2 Set to the value according to the proper tension feedback source:

- Serial: tension feedback from hidden parameter (Addr. 242 - default 0% - limits - 200%÷+200%).
- Ean2: tension feedback from Ean2 analog input (0-100%) (terminals XM1- 30, 31).
- Tach: tension feedback from Tach analog input (0-100%) (terminals XM1- 26, 27) (jumpers 8 - 9 - 10 - 11 - 12).

CJ4 Set to the tension reference value if CJ1 = P_CJ4.

CKA Set to OFF if the tension transducer (load cell, dandy roll, etc.) precedes the converter. Set to ON if the tension transducer follows the converter. See par. 8.6.

CKB Set to ON if the bumpless insertion of the tension regulator is desired: at the OFF to ON transition of Com3 command the tension reference is equalled to the tension feedback allowing the regulator enable with null error.

CKC Set to OFF if the integral gain of the tension regulator (P-I) has to be calculated as function of the speed.

Set to ON if the integral gain of the tension regulator is desired to take a constant value set by TK2 parameter.

CK3 Set to a value which re-calibrates the integral gain of the tension regulator when this is calculated as function of the speed (par. CKC = OFF).

CK1 Set to a value which re-calibrates the tension regulator output.

The tension regulator output is divided by the value set by this parameter; lower the value, greater will be the tension regulator effect in the correction of the speed reference.

CK2 Set to NLoop value; the tension regulator corrects the speed reference.

CB2 Set to AuxAdd value: the speed reference summing term is provided by the tension regulator.

The tension regulator calibration is performed assigning the values of the proportional gain and, if CKC = ON, the values of the integral gain of the regulator itself.

TK1 Set to the proportional gain value of the tension regulator.

TK2 Set to the integral gain value of the tension regulator if CKC = ON.

The tension regulator output will be limited by parameters TK3 (positive limit) and TK4 (negative limit).

TK3 Set to the positive limit value of the tension regulator output.

TK4 Set to the negative limit value of the tension regulator output.

TK5 Set to the forward limit value of the speed reference after the correction node of the tension regulator with load cell (it is enabled only if Com3 = ON).

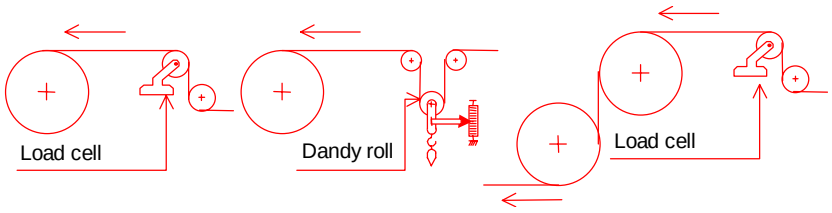
TK6 Set to the reverse limit value of the speed reference after the correction node of the tension regulator with load cell (it is enabled only if Com3 = ON).

TK7 Derivative gain of the tension regulator.

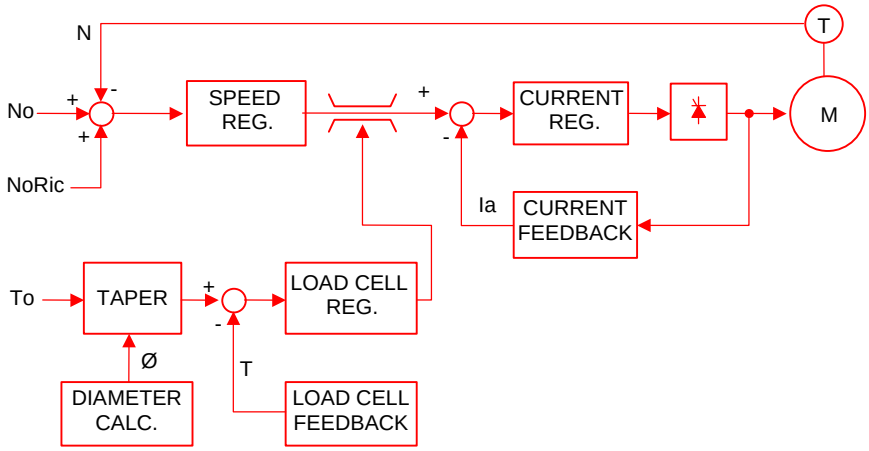
Set the parameters related to the enable and setting of the Taper function (par. 8.7).

Set the parameters related to the enable of the zero speed tension function (par. 8.8).

E5.3.2 Setting 2 (Tension loop with load cell - control of the current limit)



it is a closed loop tension regulator; the tension feedback signal is provided by a transducer (e.g. load cell or dandy roll); the regulator output is used to control the current limit, while the speed regulator is saturated by a term summed to the reference.



Blocks description:

SPEED_REG.:

Speed regulator; it is saturated by a term summed to the speed reference (NoRic).

CURRENT REG.:

Armature current regulator.

CURRENT FEEDBACK:

Armature current feedback (Ia).

TAPER:

Used when in the winder/unwinder applications the tension reference (To) has to be re-calibrated as function of the coil diameter. the re-calibration can be linear or hyperbolic type. When the function is disabled the tension reference is directly passed to the comparison node.

DIAMETER CALC.:

The diameter is acquired as analog signal provided by a proper external transducer.

LOAD CELL FEEDBACK:

Transducer of the tension feedback (T) (e.g. load cell or dandy roll). The value is acquired as analog signal.

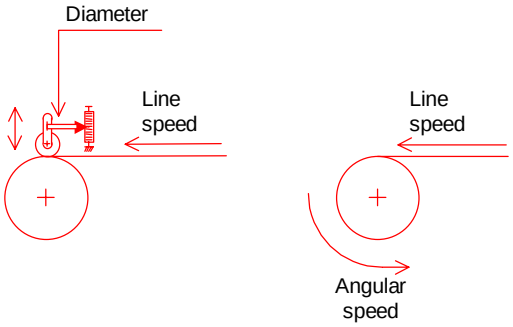
LOAD CELL REG.:

Tension regulator; it receives the tension error from the node of comparison between the tension reference and feedback and generates a term that controls the current limit.

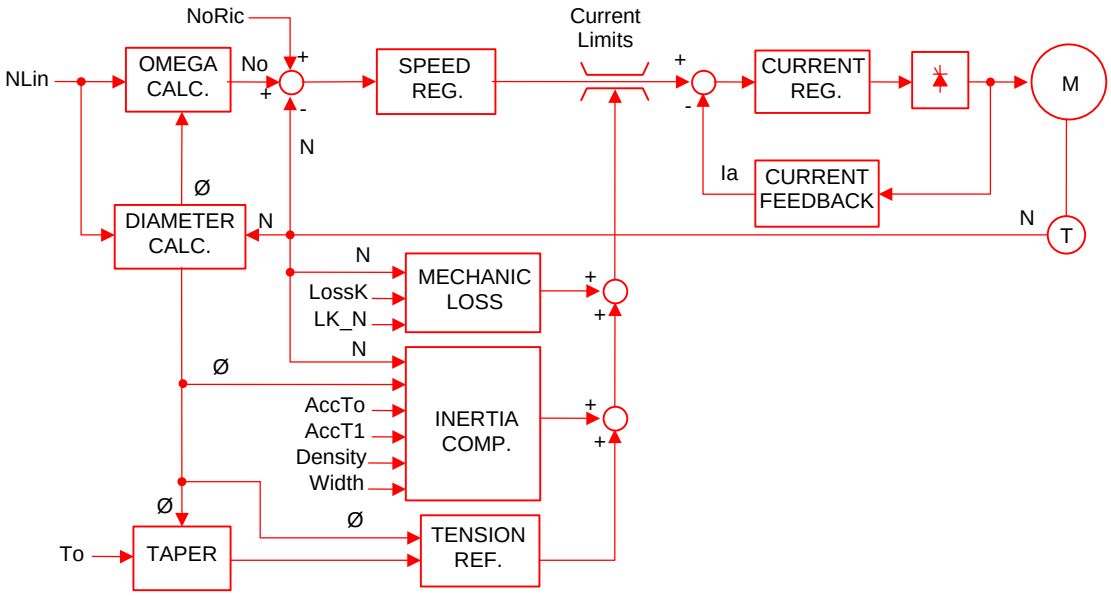
Parameters setting Setting 2 (Tension loop with load cell - control of the current limit)

CJA	Set to ON to enable the function.	
CJ1	Set to the value according to the proper tension reference source:	
	M_Pot:	tension reference from software motopotentiometer (0-100%); Com1 command increases the reference value, Com2 decreases the reference value (terminals XM1-17, XM1-18).
	Rif: t	tension reference from Rif analog input (0-100%) (terminals XM1- 33, 34).
	Ean1:	tension reference from Ean1 analog input (0-100%) (terminals XM1- 29, 31).
	P_CJ4:	tension reference from CJ4 parameter (0-100%).
CJ2	Set to the value according to the proper tension feedback source:	
	Serial:	tension feedback from hidden parameter (Addr. 242 - default 0% - limits - 200% +200%).
	Ean2:	tension feedback from Ean2 analog input (0-100%) (terminals XM1- 30, 31).
	Tach: t	tension feedback from Tach analog input (0-100%) (terminals XM1- 26, 27) (jumpers 8 - 9 - 10 - 11 - 12).
CJ4	Set to the tension reference value if CJ1 = P_CJ4.	
CKA	Set to OFF if the tension transducer (load cell, dandy roll, etc.) precedes the converter.	
	Set to ON if the tension transducer follows the converter. See par. 8.6.	
CKB	Set to ON if the bumpless insertion of the tension regulator is desired: at the OFF to ON transition of Com3 command the tension reference is equalled to the tension feedback allowing the regulator enable with null error.	
CKC	Set to OFF if the integral gain of the tension regulator (P-I) has to be calculated as function of the speed.	
	Set to ON if the integral gain of the tension regulator is desired to take a constant value set by TK2 parameter.	
CK3	Set to a value which re-calibrates the integral gain of the tension regulator when this is calculated as function of the speed (par. CKC = OFF).	
CK1	Set to a value which re-calibrates the tension regulator output.	
	The tension regulator output is divided by the value set by this parameter; lower the value, greater will be the tension regulator effect in the correction of the speed reference.	
CK2	Set to ILoop value; the tension regulator acts on the current limit (speed regulator saturated by a summing term).	
CB2	Set to AuxAdd value: the speed reference summing term has the value set by CE1 parameter.	
CE1	Set to the value needed by the speed reference summing term to maintain proper saturated the speed regulator (offset speed).	
CA2	Set to AuxRic value: the current limits are controlled by the tension regulator.	
	The tension regulator calibration is performed assigning the values of the proportional gain and, if CKC = ON, the values of the integral gain of the regulator itself.	
TK1	Set to the proportional gain value of the tension regulator.	
TK2	Set to the integral gain value of the tension regulator if CKC = ON.	
	The tension regulator output will be limited by parameters TK3 (positive limit) and TK4 (negative limit).	
TK3	Set to the positive limit value of the tension regulator output.	
TK4	Set to the negative limit value of the tension regulator output.	
	Set the parameters related to the enable and setting of the Taper function (par. 8.7).	
	Set the parameters related to the enable of the zero speed tension function (par. 8.8).	

E5.3.3 Setting 3 (Axial winder - control of the current limit)



it is an open loop tension regulator; it used for winder or unwinder systems; the terms related to the tension reference, to the inertia compensation and to mechanical losses compensation are calculated and summed by a summing node whose output controls the current limit; the speed regulator is saturated by a term summed to the reference. The information related to the diameter value can be acquired by an external transducer or it can be calculated as line speed / angular speed ratio.



Blocks description:

SPEED_REG.:
Speed regulator; it is saturated by a term summed to the speed reference (NoRic).

OMEGA CALC.:
The angular speed reference is calculated from the line speed as function of the calculated/acquired diameter.

CURRENT REG.:
Armature current regulator.

CURRENT FEEDBACK:
Armature current feedback (Ia).

TAPER:
Used when in the winder/unwinder applications the tension reference (To) has to be re-calibrated as function of the coil diameter. the re-calibration can be linear or hyperbolic type. When the function is disabled the tension reference is directly passed to the comparison node.

DIAMETER CALC.:
The diameter is calculated as line speed / angular speed ratio, or it is acquired as analog signal provided by a proper external transducer.

TENSION REF.:
It evaluates the term related to the tension reference.

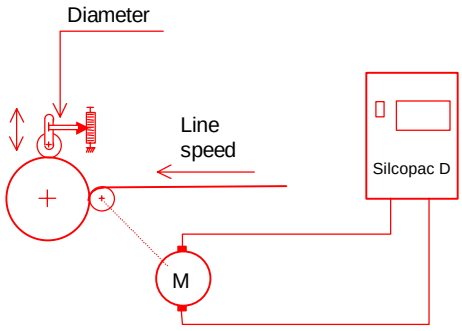
INERTIA COMP.:
It evaluates the term related to the inertia compensation that is function of: speed variation, diameter, machine acceleration times, material density and tape width.

MECHANIC LOSS:
It evaluates the term related to the mechanical loss compensation; a constant term and a speed related term.

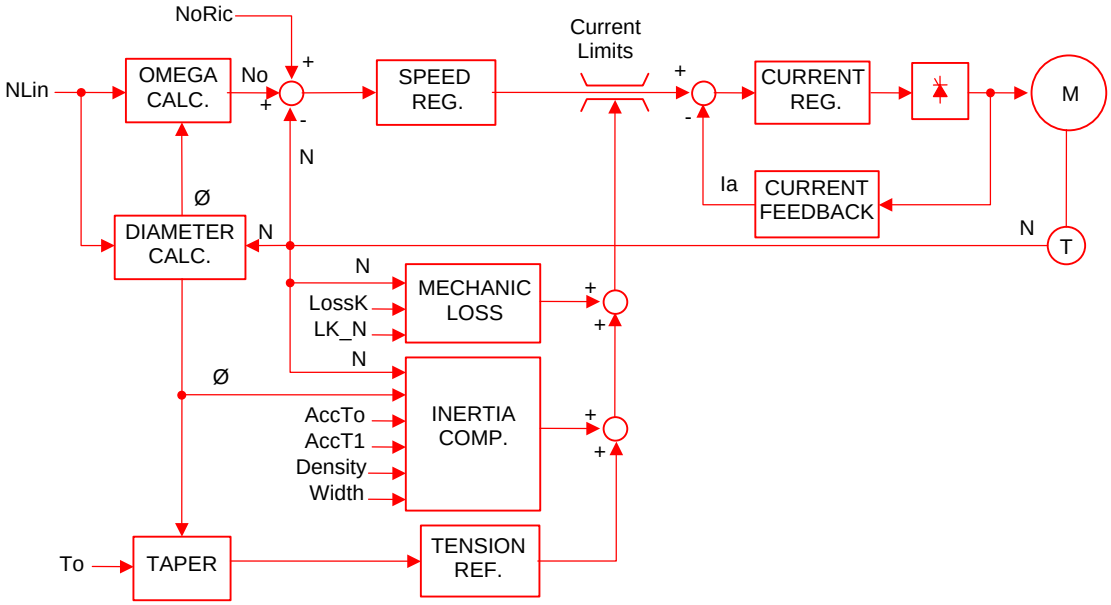
Parameters setting Setting 3 (Axial winder - control of the current limit)

CJB	Set to ON to enable the function.
CJ1	Set to the value according to the proper tension reference source: Rif: tension reference from Rif analog input (0-100%) (terminals XM1- 33, 34). Ean1: tension reference from Ean1 analog input (0-100%) (terminals XM1- 29, 31). P_CJ4: tension reference from CJ4 parameter (0-100%).
CJ4	Set to the tension reference value if CJ1 = P_CJ4.
CL1	Set to Axial value: axial winder.
CL2	Set to the cutoff frequency value of the double slope digital filter at the regulator output (to disable set CL2 = 0).
CL3	Set to Wind value for winder reel. Set to Unwind value for unwinder reel.
CL4	Set to Normal if the passage of the material on the winder/unwinder is that defined for the normal operation. Set to Rev. if the passage of the material on the winder/unwinder is opposite to that defined for the normal operation (e.g.: Normal = material top winded, Rev. = material bottom winded or vice-versa). Set to Com6 if the operating condition (Normal/Rev.) is defined by the Com6 analog input status (available on the SPDIO optional board); Com6 not active: Normal operation; Com6 active: Rev. operation.
CL5	Set to the current value (expressed in percentages, depending on the motor rated current) needed to apply the desired tension to maximum diameter. (see E5.11 parameter)
CB2	Set to AuxAdd value: the speed reference summing term has the value set by CE1 parameter.
CE1	Set to the value needed by the speed reference summing term to maintain proper saturated the speed regulator (offset speed).
CA2	Set to AuxRic value: the current limits are controlled by the tension regulator.
	Set the parameters related to the enable and setting of the Taper function (par. 8.7). Set the parameters related to the enable of the zero speed tension function (par. 8.8). Set the parameters related to the enable of the inertia compensation function (par. 8.10). Set the parameters related to the enable of the mechanical losses compensation function). Set the parameters related to the enable of the diameter calculation/acquisition function (par. 8.9).
CK2	Winder

E5.3.4 Setting 4 (Tangential winder - control of the current limit)



it is an open loop tension regulator; it used for winder or unwinder systems (the motorized cylinder transmits the rotation to the winder cylinder); the terms related to the tension reference, to the inertia compensation and to mechanical losses compensation are calculated and summed by a summing node whose output controls the current limit; the speed regulator is saturated by a term summed to the reference. The diameter value is acquired by an external transducer.



Blocks description:

SPEED_REG.:
Speed regulator; it is saturated by a term summed to the speed reference (NoRic).

OMEGA CALC.:
The angular speed reference is calculated from the line speed as function of the calculated/acquired diameter.

CURRENT REG.:
Armature current regulator.

CURRENT FEEDBACK:
Armature current feedback (Ia).

TAPER:
Used when in the winder/unwinder applications the tension reference (To) has to be re-calibrated as function of the coil diameter. the re-calibration can be linear or hyperbolic type. When the function is disabled the tension reference is directly passed to the comparison node.

DIAMETER CALC.:
The diameter is acquired as analog signal provided by a proper external transducer.

INERTIA COMP.:
It evaluates the term related to the inertia compensation that is function of: speed variation, diameter, machine acceleration times, material density and tape width.

MECHANIC LOSS:
It evaluates the term related to the mechanical loss compensation; a constant term and a speed related term.

TENSION REF.:
It evaluates the term related to the tension reference.

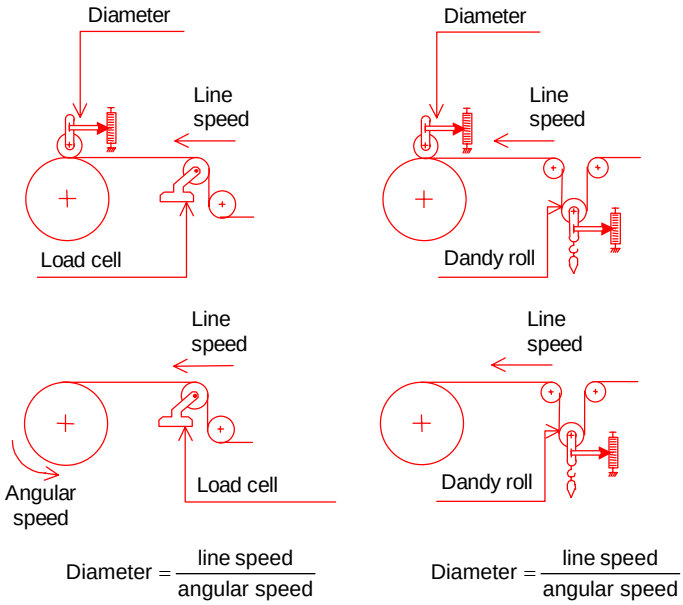
Parameters setting Setting 4 (Tangential winder - control of the current limit)

CJB	Set to ON to enable the function.
CJ1	Set to the value according to the proper tension reference source: Rif: tension reference from Rif analog input (0-100%) (terminals XM1- 33, 34). Ean1: tension reference from Ean1 analog input (0-100%) (terminals XM1- 29, 31). P_CJ4: tension reference from CJ4 parameter (0-100%).
CJ4	Set to the tension reference value if CJ1 = P_CJ4.
CL1	Set to Tang. value: tangential winder.
CL2	Set to the cutoff frequency value of the double slope digital filter at the regulator output (to disable set CL2 = 0).
CL3	Set to Wind value for winder reel. Set to Unwind value for unwinder reel.
CL4	Set to Normal if the passage of the material on the winder/unwinder is that defined for the normal operation. Set to Rev. if the passage of the material on the winder/unwinder is opposite to that defined for the normal operation (e.g.: Normal = material top winded, Rev. = material bottom winded or vice-versa). Set to Com6 if the operating condition (Normal/Rev.) is defined by the Com6 analog input status (available on the SPDIO optional board); Com6 not active: Normal operation; Com6 active: Rev. operation.
CL5	Set to the current value (expressed in percentages, depending on the motor rated current) needed to apply the desired tension to maximum diameter. (see E5.11 parameter)
CB2	Set to AuxAdd value: the speed reference summing term has the value set by CE1 parameter.
CE1	Set to the value needed by the speed reference summing term to maintain proper saturated the speed regulator (offset speed).
CA2	Set to AuxRic value: the current limits are controlled by the tension regulator.

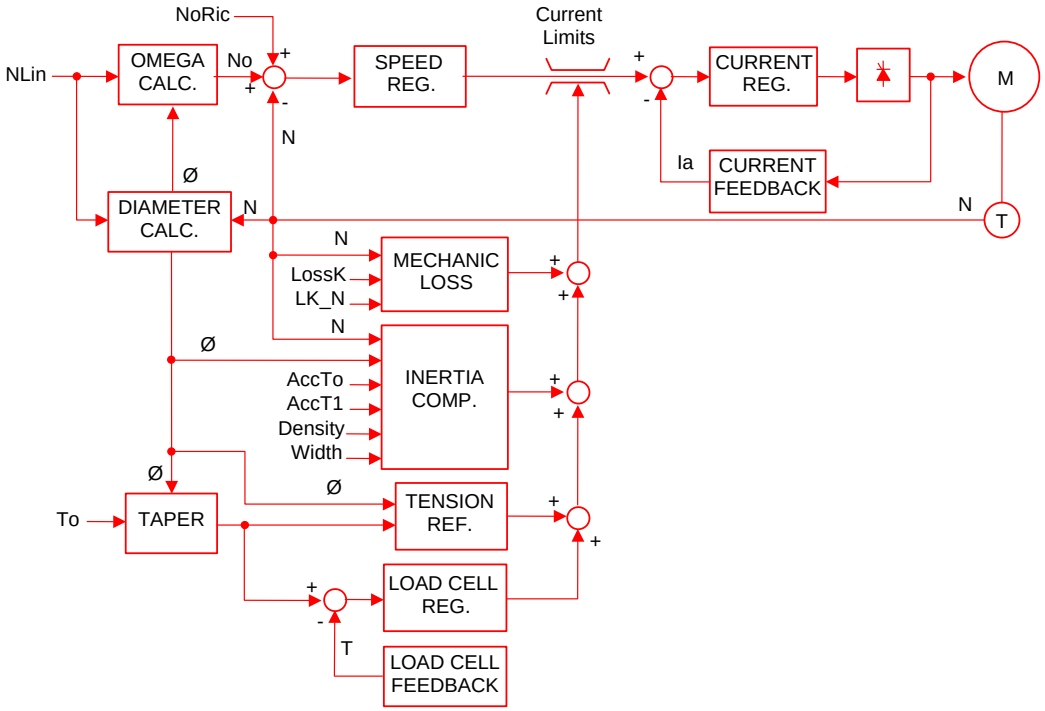
Set the parameters related to the enable and setting of the Taper function (par. 8.7).
Set the parameters related to the enable of the zero speed tension function (par. 8.8).

Set the parameters related to the enable of the inertia compensation function (par. 8.10).
Set the parameters related to the enable of the mechanical losses compensation function.
Set the parameters related to the enable of the diameter calculation/acquisition function (par. 8.9).

E5.3.5 Setting 5 (Axial winder + tension loop with load cell - control of the current limit)



In this case both regulators are active; this setting is used for winder or unwinder systems. The axial winder function evaluates the terms related to the tension reference, to the inertia compensation and to mechanical losses compensation; the tension loop function with load cell compares the reference to the tension feedback and generates, through a proportional-integral regulator, a term which corrects the tension inaccuracies; the terms calculated by the axial winder and tension loop functions are summed by a summing node whose output controls the current limit; the speed regulator is saturated by a term summed to the reference. The information related to the diameter value can be acquired by an external transducer or it can be calculated as line speed / angular speed ratio.



Blocks description:

SPEED_REG.:
Speed regulator; it is saturated by a term summed to the speed reference (NoRic).

OMEGA CALC.:
The angular speed reference is calculated from the line speed as function of the calculated/acquired diameter.

CURRENT REG.:
Armature current regulator.

CURRENT FEEDBACK:
Armature current feedback (Ia).

TAPER:
Used when in the winder/unwinder applications the tension reference (To) has to be re-calibrated as function of the coil diameter. the re-calibration can be linear or hyperbolic type. When the function is disabled the tension reference is directly passed to the comparison node.

DIAMETER CALC.:
The diameter is calculated as line speed / angular speed ratio, or it is acquired as analog signal provided by a proper external transducer.

TENSION REF.:
It evaluates the term related to the tension reference.

INERTIA COMP.:
It evaluates the term related to the inertia compensation that is function of: speed variation, diameter, machine acceleration times, material density and tape width.

MECHANIC LOSS:
It evaluates the term related to the mechanical loss compensation; a constant term and a speed related term.

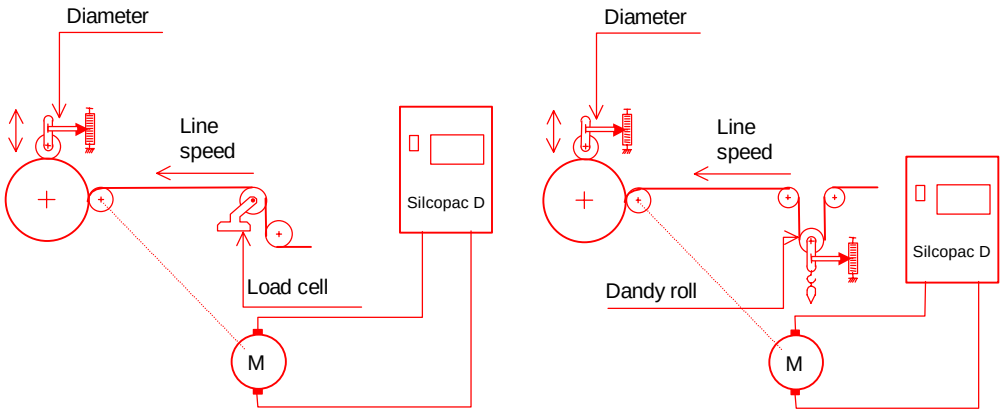
LOAD CELL:
Transducer of the tension feedback (T) (e.g. load cell or dandy roll). The value is acquired as analog signal.

LOAD CELL REG.:
Tension regulator; it receives the tension error from the node of comparison between the tension reference and feedback and generates a term that control the current limit.

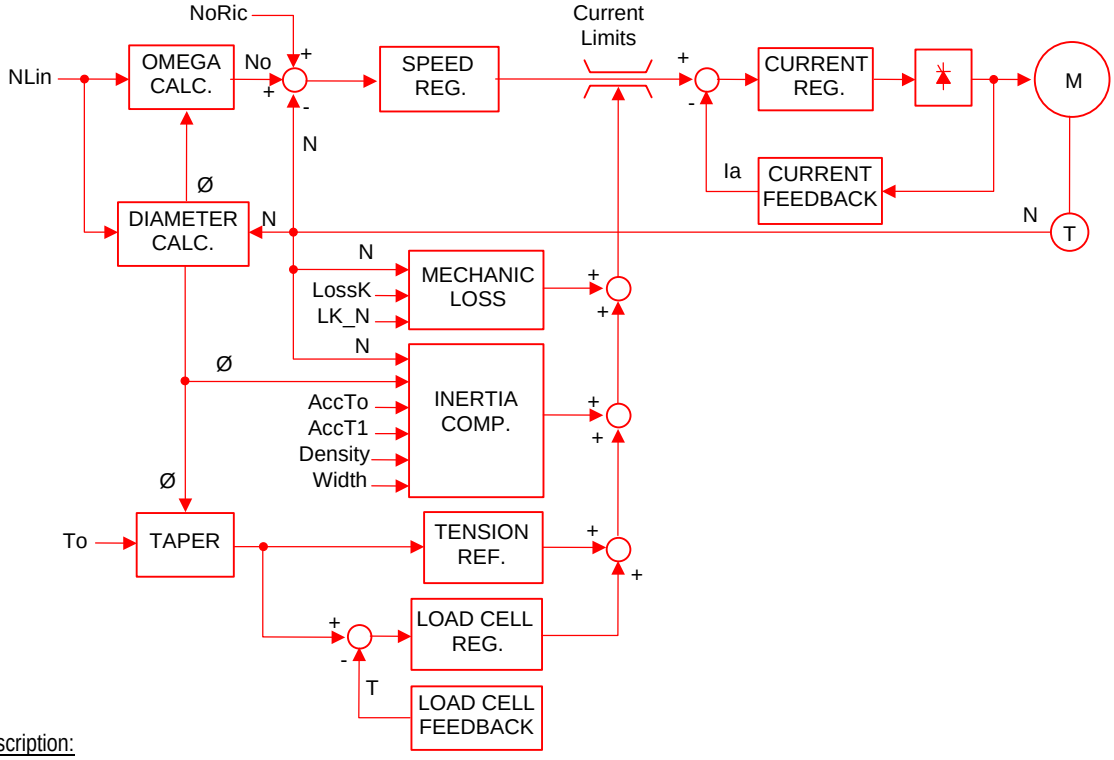
Parameters setting Setting 5 (Axial winder + tension loop with load cell - control of the current limit)

CJA	Set to ON to enable the tension regulator with load cell.
CJB	Set to ON to enable the winder.
CJ1	Set to the value according to the proper tension reference source: Rif: tension reference from Rif analog input (0-100%) (terminals XM1- 33, 34). Ean1: tension reference from Ean1 analog input (0-100%) (terminals XM1- 29, 31). P_CJ4: tension reference from CJ4 parameter (0-100%).
CJ2	Set to the value according to the proper tension feedback source: Serial: tension feedback from hidden parameter (Addr. 242 - default 0% - limits - 200% +200%). Ean2: tension feedback from Ean2 analog input (0-100%) (terminals XM1- 30, 31). Tach: tension feedback from Tach analog input (0-100%) (terminals XM1- 26, 27) (jumpers 8-9-10-11-12).
CJ4	Set to the tension reference value if CJ1 = P_CJ4.
CKA	Set to OFF if the tension transducer (load cell, dandy roll, etc.) precedes the converter. Set to ON if the tension transducer follows the converter. See par. 8.6.
CKB	Set to ON if the bumpless insertion of the tension regulator is desired: at the OFF to ON transition of Com3 command the tension reference is equalled to the tension feedback allowing the regulator enable with null error.
CKC	Set to OFF if the integral gain of the tension regulator (P-I) has to be calculated as function of the speed. Set to ON if the integral gain of the tension regulator is desired to take a constant value set by TK2 parameter.
CK3	Set to a value which re-calibrates the integral gain of the tension regulator when this is calculated as function of the speed (par. CKC = OFF).
CK1	Set to a value which re-calibrates the tension regulator output. The tension regulator output is divided by the value set by this parameter; lower the value, greater will be the tension regulator effect in the correction of the speed reference.
CK2	Set to Winder value; the tension regulator acts on the current limit (speed regulator saturated by a summing term).
CL1	Set to Axial value: axial winder.
CL2	Set to the cutoff frequency value of the double slope digital filter at the regulator output (to disable set CL2 = 0).
CL3	Set to Wind value for winder reel. Set to Unwind value for unwinder reel.
CL4	Set to Normal if the passage of the material on the winder/unwinder is that defined for the normal operation. Set to Rev. if the passage of the material on the winder/unwinder is opposite to that defined for the normal operation (e.g.: Normal = material top winded, Rev. = material bottom winded or vice-versa). Set to Com6 if the operating condition (Normal/Rev.) is defined by the Com6 analog input status (available on the SPDIO optional board); Com6 not active: Normal operation; Com6 active: Rev. Operation.
CL5	Set to the current value (expressed in percentages, depending on the motor rated current) needed to apply the desired tension to maximum diameter.
CB2	Set to AuxAdd value: the speed reference summing term has the value set by CE1 parameter.
CE1	Set to the value needed by the speed reference summing term to maintain proper saturated the speed regulator (offset speed).
CA2	Set to AuxRic value: the current limits are controlled by the tension regulator. The tension regulator calibration is performed assigning the values of the proportional gain and, if CKC = ON, the values of the integral gain of the regulator itself.
TK1	Set to the proportional gain value of the tension regulator.
TK2	Set to the integral gain value of the tension regulator if CKC = ON. The tension regulator output will be limited by parameters TK3 (positive limit) and TK4 (negative limit).
TK3	Set to the positive limit value of the tension regulator output.
TK4	Set to the negative limit value of the tension regulator output.
	Set the parameters related to the enable and setting of the Taper function (par. 8.7). Set the parameters related to the enable of the zero speed tension function (par. 8.8). Set the parameters related to the enable of the inertia compensation function (par. 8.10). Set the parameters related to the enable of the mechanical losses compensation function. Set the parameters related to the enable of the diameter calculation/acquisition function (par. 8.9).

E5.3.6 Setting 6 (Tangential winder + tension loop with load cell - control of the current limit)



In this case both regulators are active; this setting is used for winder or unwinder systems (the motorized cylinder transmits the rotation to the winder cylinder).
The axial winder function evaluates the terms related to the tension reference, to the inertia compensation and to mechanical losses compensation; the tension loop function with load cell compares the reference to the tension feedback and generates, through a proportional-integral regulator, a term which corrects the tension inaccuracies; the terms calculated by the axial winder and tension loop functions are summed by a summing node whose output controls the current limit; the speed regulator is saturated by a term summed to the reference. The diameter value is acquired by an external transducer.



Blocks description:

SPEED_REG.: Speed regulator; it is saturated by a term summed to the speed reference (NoRic).

OMEGA CALC.: The angular speed reference is calculated from the line speed as function of the calculated/acquired diameter.

CURRENT REG.: Armature current regulator.

CURRENT FEEDBACK: Armature current feedback (Ia).

TAPER: Used when in the winder/unwinder applications the tension reference (To) has to be re-calibrated as function of the coil diameter. the re-calibration can be linear or hyperbolic type. When the function is disabled the tension reference is directly passed to the comparison node.

DIAMETER CALC.: The diameter is calculated as line speed / angular speed ratio, or it is acquired as analog signal provided by a proper external transducer.

INERTIA COMP.: It evaluates the term related to the inertia compensation that is function of: speed variation, diameter, machine acceleration times, material density and tape width.

MECHANIC LOSS: It evaluates the term related to the mechanical loss compensation; a constant term and a speed related term.

LOAD CELL: Transducer of the tension feedback (T) (e.g. load cell or dandy roll). The value is acquired as analog signal.

LOAD CELL REG.: Tension regulator; it receives the tension error from the node of comparison between the tension reference and feedback and generates a term that control the current limit.

TENSION REF.: It evaluates the term related to the tension reference.

Parameters setting Setting 6 (Tangential winder + tension loop with load cell - control of the current limit)

CJA	Set to ON to enable the tension regulator with load cell.
CJB	Set to ON to enable the winder.
CJ1	Set to the value according to the proper tension reference source: Rif: tension reference from Rif analog input (0-100%) (terminals XM1- 33, 34). Ean1: tension reference from Ean1 analog input (0-100%) (terminals XM1- 29, 31). P_CJ4: tension reference from CJ4 parameter (0-100%).
CJ2	Set to the value according to the proper tension feedback source: Serial: tension feedback from hidden parameter (Addr. 242 - default 0% - limits - 200%). Ean2: tension feedback from Ean2 analog input (0-100%) (terminals XM1- 30, 31). Tach: tension feedback from Tach analog input (0-100%) (terminals XM1- 26, 27) (jumpers 8-9-10-11-12).
CJ4	Set to the tension reference value if CJ1 = P_CJ4.
CKA	Set to OFF if the tension transducer (load cell, dandy roll, etc.) precedes the converter. Set to ON if the tension transducer follows the converter. See par. 8.6.
CKB	Set to ON if the bumpless insertion of the tension regulator is desired: at the OFF to ON transition of Com3 command the tension reference is equalled to the tension feedback allowing the regulator enable with null error.
CKC	Set to OFF if the integral gain of the tension regulator (P-I) has to be calculated as function of the speed. Set to ON if the integral gain of the tension regulator is desired to take a constant value set by TK2 parameter.
CK3	Set to a value which re-calibrates the integral gain of the tension regulator when this is calculated as function of the speed (par. CKC = OFF).
CK1	Set to a value which re-calibrates the tension regulator output. The tension regulator output is divided by the value set by this parameter; lower the value, greater will be the tension regulator effect in the correction of the speed reference.
CK2	Set to Winder value; the tension regulator acts on the current limit (speed regulator saturated by a summing term).
CL1	Set to Tang. value: tangential winder.
CL2	Set to the cutoff frequency value of the double slope digital filter at the regulator output (to disable set CL2 = 0).
CL3	Set to Wind value for winder reel. Set to Unwind value for unwinder reel.
CL4	Set to Normal if the passage of the material on the winder/unwinder is that defined for the normal operation. Set to Rev. if the passage of the material on the winder/unwinder is opposite to that defined for the normal operation (e.g.: Normal = material top winded, Rev. = material bottom winded or vice-versa). Set to Com6 if the operating condition (Normal/Rev.) is defined by the Com6 analog input status (available on the SPDIO optional board); Com6 not active: Normal operation; Com6 active: Rev. Operation.
CL5	Set to the current value (expressed in percentages, depending on the motor rated current) needed to apply the desired tension to maximum diameter.
CB2	Set to AuxAdd value: the speed reference summing term has the value set by CE1 parameter.
CE1	Set to the value needed by the speed reference summing term to maintain proper saturated the speed regulator (offset speed).
CA2	Set to AuxRic value: the current limits are controlled by the tension regulator. The tension regulator calibration is performed assigning the values of the proportional gain and, if CKC = ON, the values of the integral gain of the regulator itself.
TK1	Set to the proportional gain value of the tension regulator.
TK2	Set to the integral gain value of the tension regulator if CKC = ON. The tension regulator output will be limited by parameters TK3 (positive limit) and TK4 (negative limit).
TK3	Set to the positive limit value of the tension regulator output.
TK4	Set to the negative limit value of the tension regulator output.
	Set the parameters related to the enable and setting of the Taper function (par. E5.7). Set the parameters related to the enable of the zero speed tension function (par. E5.8). Set the parameters related to the enable of the inertia compensation function (par. E5.10). Set the parameters related to the enable of the mechanical losses compensation function. Set the parameters related to the enable of the diameter calculation/acquisition function (par. E5.9).
TK7	Set to the derivative gain value of the tension regulator.

E5.4 Commands

All the tension regulators are enabled by Com3 command (terminal XM1- 19).
Com3 command cannot therefore be used to perform other functions and DN3 parameter must be set to OFF.

E5.4.1 Setting 1

When Com3 command is not active, the system is speed regulated and the summing term of the speed reference is disabled.
When Com3 command is active, the system is speed regulated and the regulator output is summed to the speed reference (correction).

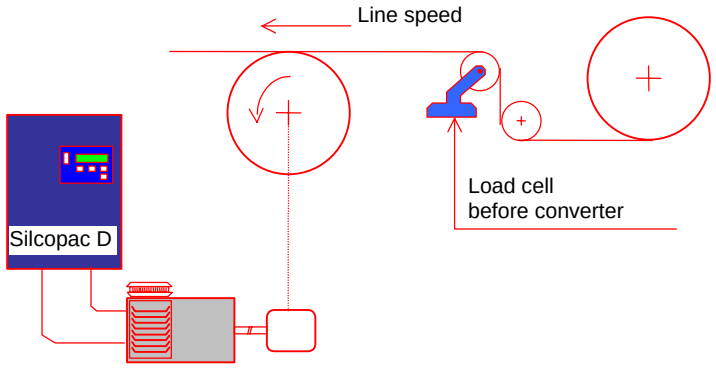
E5.4.2 Settings 2, 3, 4, 5 and 6

When Com3 command is not active, the system is speed regulated: the current limits take the values set by TA3 and TA4 parameters; no term is summed to the speed reference.
When Com3 command is active, the tension regulator is enabled: one of the current limits is controlled by the tension regulator output (the other limit take the value set by the proper TA3 or TA4 parameter), the speed regulator is saturated enabling a term summed to the speed reference (the summing term value is set by CE1 parameter).

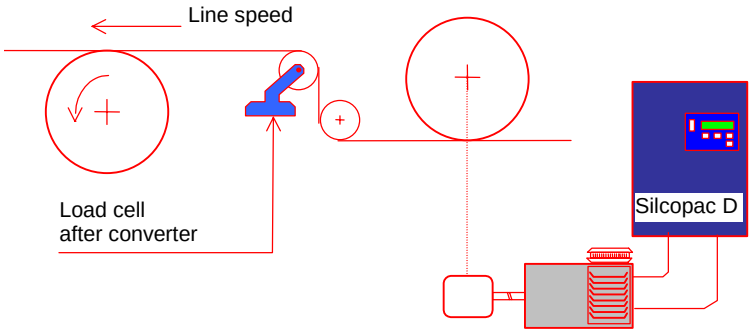
E5.5 Position of the tension transducer

Parameter CKA defines the load cell position in respect to the motorized cylinder as function of the line speed direction.

CKA = OFF
the load cell is located before the converter: increasing the tension, the tension regulator output decreases to reduce the speed or the torque.



CKA = ON
the load cell is located after the converter: increasing the tension, the tension regulator outputincreases to increase the speed or the torque.

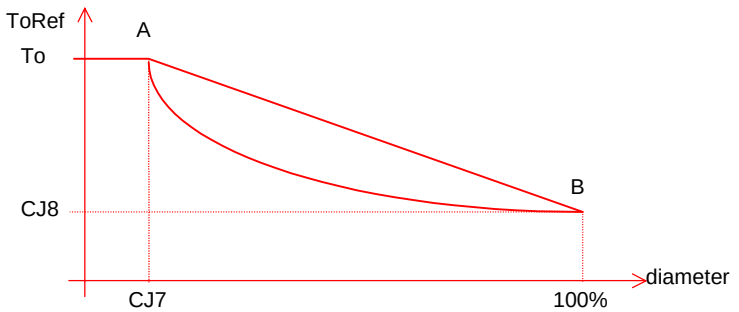


E5.6 Taper function

The Taper function is interposed between the tension reference source and the operating tension reference. It performs a programmed reduction of the tension reference as function of the diameter (calculated/acquired).

Parameters

CJC	Set to ON to enable the function.
CJ6	Set to Lin. value to obtain a linear shape of the tension reduction as function of the diameter Set to Hyp. value to obtain a hyperbolic shape of the tension reduction as function of the diameter.
CJ7	Set to the diameter value (%) starting from which the Taper function begins.
CJ8	Set to the value that the tension reference will have to reach when, being the Taper function enabled, the diameter will be at its maximum value (100%).

Description	
In a orthogonal axes system, points A = (CJ7, ToRef) and B = (100%, CJ8) are connected by a continuous function with a linear shape (CJ6 = Lin.) or with a hyperbolic shape (CJ6 = Hyp.).	

E5.7 Zero speed tension

Parameter CJ3 allows to enable the acquisition of a tension reference set by parameter CJ4 that replaces the selected tension reference through parameter CJ1 according to the following principles:

CJ3 = ToN0Of — The acquisition of the zero speed tension reference is disabled; the tension reference selected by CJ1 parameter is always active.

CJ3 = ToN0On — When the system reaches the zero speed (see CB5 and CB6 parameters), the tension reference selected by CJ1 parameter is replaced by the value set by CJ5 parameter. The acquisition of the new value (CJ5) is filtered by a ramp programmable by the par. CJ9. When the system leaves the zero speed status, the operating tension reference is restored to the value set by CJ1 parameter. The acquisition of the new value (selected by CJ1) is filtered by a ramp programmable by the par. CJ9.

CJ3 = COM6 — When Com6 logic input (available on the SPDIO optional board) goes to its active status, the tension reference selected by CJ1 parameter is replaced by the value set by CJ5 parameter. The acquisition of the new value (CJ5) is filtered by a ramp programmable by the par. CJ9. When Com6 logic input leaves its active status, the operating tension reference is restored to the value set by CJ1 parameter. The acquisition of the new value (selected by CJ1) is filtered by a ramp programmable by the par. CJ9.

CJ3 = COM7 — When Com7 logic input (available on the SPDIO optional board) goes to its active status, the tension reference selected by CJ1 parameter is replaced by the value set by CJ5 parameter. The acquisition of the new value (CJ5) is filtered by a ramp programmable by the par. CJ9. When Com7 logic input leaves its active status, the operating tension reference is restored to the value set by CJ1 parameter. The acquisition of the new value (selected by CJ1) is filtered by a ramp programmable by the par. CJ9.

E5.8 Acquisition / Calculation of the diameter

The diameter information (acquired by an external transducer or measured as line speed / angular speed ratio) is used in many of the applications listed in this chapter; it is particularly used by the Taper function and by all settings described for the calculation of the inertia compensation and for the calculation of the term related to the tension reference. These are, however, all applications requiring winding or un-winding of a given material.
It is always possible to acquire the signal proportional to the diameter (0-10V) through an analog input (Ean1 or Ean2; terminals XM1- 29, 31 and XM1-30, 31).
Only in applications where an axial winder is used (settings 3 and 5) it is possible to obtain the diameter information evaluating the line speed to angular speed ratio.
The diameter value is always in the range defined by a minimum (CN1 parameter) and a maximum value (100%). The maximum diameter value (100%) must be related to the maximum allowed diameter of the machine. The minimum value is related to the core diameter as percent of the maximum value.

Example: Max diameter = 4m = 100%
Min diameter = 0.5m = 12.5%

Note. The calculated diameter value is not stored if the SPDM converter is switched off.

Function calibration

External diameter transducer.
Check that the transducer gives a 0V output voltage at the minimum diameter (minimum spindle without material).
Check that the transducer gives a 10V output voltage at the maximum diameter allowed by the machine.

Diameter calculated as line speed to angular speed ratio
In minimum diameter conditions (minimum spindle without material) and reel function disabled (COM3 = OFF), check that the linear speed measured on the minimum spindle be equal to the maximum line speed, when a 100% reference is applied (Setup Reference - Cont. Speed Ref.). If this is not, adjust CB8 parameter (if CB3 = Encod) or DJ1 parameter (if CB3 = Tach) until the proper linear speed value will be reached.

Diameter ramp

Parameter CN5 must be set to the time value, as seconds, needed by the system to go from the minimum to the maximum diameter (winder) or vice versa (un-winder) when the line speed has its maximum value (100%).
All the diameter variations greater than those allowed by the set value are filtered.

Increasing sequence

When the machine wind the material, the diameter must take increasing values until its maximum value (100%) will be reached at the end of the working cycle.
In this case CL3 parameter will be set to Wind value; each new diameter value will be compared to the last previously acquired/calculated value and, if lower, it will be ignored.

Decreasing sequence

When the machine unwind the material, the diameter must take decreasing values until its minimum value (CN1) will be reached at the end of the working cycle.
In this case CL3 parameter will be set to Unwind value; each new diameter value will be compared to the last previously acquired/calculated value and, if greater, it will be ignored.

Minimum speed

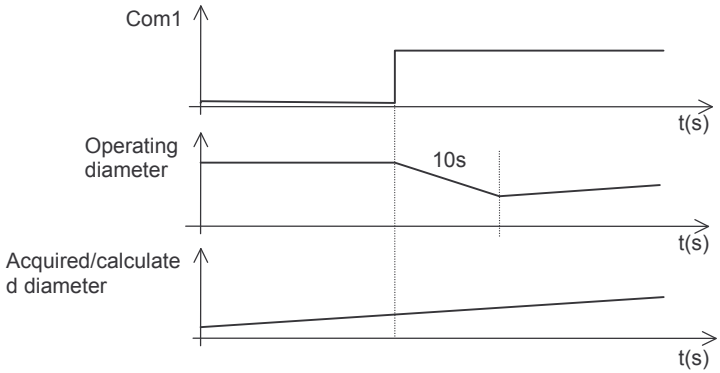
When the diameter is calculated (par. CN6 = Calc.), the machine is needed to be running at a minimum speed so that a reliable calculation can be made. The minimum angular speed before which the diameter will not be calculated (the last valid value is active) must be set by CN4 parameter.

Commands

The application of filters (diameter ramp and increasing/decreasing sequence) may cause some errors on the diameter information; this may occur, e.g., when in a winder application, arrived at the max diameter, the coil is replaced and the working cycle restarts from a diameter lower than the last calculated/acquired one (erroneous information due to the increasing sequence); another case is when in a winder application, having set the min diameter, the working cycle restarts from a greater diameter (erroneous information due to the diameter ramp).
Com1 and Com2 logic commands allow to acquire or to set, bypassing the filters, the proper diameter value starting from which the application of the filters themselves assure a coherent data value.

Com1 command

At the rising edge of Com1 command (terminal XM1-17, transition from inactive to active command), if the angular speed of the winder is lower than 20%, the acquired/calculated diameter in that moment become the operating diameter; the filters made by the diameter ramp (8.9.2) and by the increasing/decreasing sequence (8.9.3 / 8.9.4) will be ignored. The transition from last operating diameter before the rising edge of Com1 to the new diameter occurs through a 10s ramp.



The figure shows the condition, with a winder, in which the new acquired/calculated diameter is lower than the last operating value. At the rising edge of Com1 command the diameter goes to the proper value by a 10s ramp.

Com2 command

At the rising edge of Com2 command (terminal XM1-17, transition from inactive to active command), the starting diameter, whose source is set by CN2 parameter, is immediately acquired.

Parameters

CN1	Set to the minimum diameter value (core) as percentage of the maximum diameter.
CN2	Set this parameter to select the source of the starting diameter:
	P_CN3: starting diameter from CN3 parameter
	Ean1: starting diameter from Ean1 analog input (terminals XM1-29, 31)
	Ean2: starting diameter from Ean2 analog input (terminals XM1-30, 31)
CN3	Set to the starting diameter value when CN2 = P_CN3.
CN4	Set to the speed threshold before which the diameter is not calculated
CN5	Set this parameter to select the diameter source:
	Calc.: calculated diameter (axial reel only)
	Ean1: diameter from Ean1 analog input (terminals XM1-29, 31)
	Ean2: diameter from Ean2 analog input (terminals XM1-30, 31)
CN6	Disabling time of the diameter calculation function after the Start command.

E5.9 Inertia compensation

Every time a speed variations is needed, the regulator must win the inertia of the load coupled to the motor.
In all applications with winder or unwinder reel, the mass and as consequence the inertia of a winded/unwinded coil varies as function of the width of the coil itself, the material density and the diameter.

E5.9.1 Axial winder

For proper calibration of the coil inertia compensation it is needed to set two machine acceleration times (the acceleration time can be measured according to the sequence described at par. 5.2):
1 - empty reel acceleration time (only the core cylinder without material).
2 - max reel acceleration time (max diameter, max coil width, max material density).

When, because of practical reasons, the machine acceleration time measurement at max reel cannot be made, the acceleration time with a convenient coil as near as possible to the max coil can be measured. Applying the formula described at par. 8.10.3 section E, the acceleration time that would be measured in max reel conditions can be calculated.

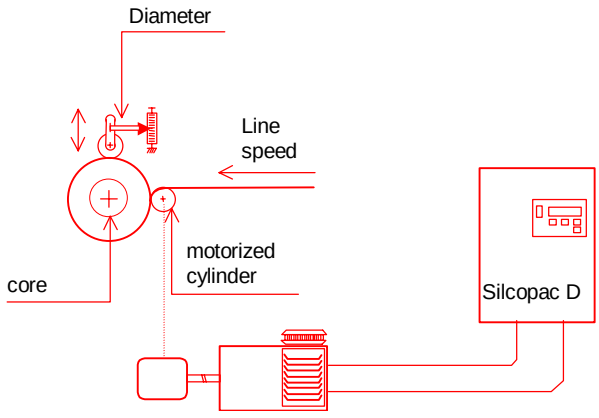
Parameters:

CMA	Set to ON to enable the function.
CM1	Set to Var. value to enable the calculation of the reel inertia compensation.
CM2	Set this parameter to select the source of the information related to the material density (as percentage of the max value allowed by the machine): P_CM4: density from CM4 parameter; Ean2: density from Ean2 analog input (terminals XM1-30, 31) If: density from If analog input (terminal XM1-28, 31)
CM3	Set this parameter to select the source of the information related to the coil width (as percentage of the max value allowed by the machine): P_CM5: width from CM5 parameter Ean2: width from Ean2 analog input (terminals XM1-30, 31) Tach: width from Tach analog input (terminals XM1-26, 27) (Jumpers 8, 9, 10, 11, 12) If: width from If analog input (terminal XM1-28, 31)
CM4	Set to the density value when CM2= = P_CM4.
CM5	Set to the coil width value when CM3= = P_CM5.
CM6	Set to the machine acceleration time value (s) measured in empty reel conditions.
CM7	Set to the machine acceleration time value (s) measured in max reel conditions.

E5.9.2 Tangential winder

For proper calibration of the coil inertia compensation it is needed to set three machine acceleration times (the acceleration time can be measured according to the sequence described at par. 5.2):

1 - motorized cylinder acceleration time
2 - empty reel acceleration time (with the core cylinder supported to the motorized cylinder, without material)
3 - max reel acceleration time (max diameter, max coil width, max material density).



When, because of practical reasons, the machine acceleration time measurement at max reel cannot be made, the acceleration time with a convenient coil as near as possible to the max coil can be measured. Applying the formula described at par. 8.10.4, the acceleration time that would be measured in max reel conditions can be calculated.

Parameters:

CMA	Set to ON to enable the function.
CM1	Set to Var. value to enable the calculation of the reel inertia compensation.
CM2	Set this parameter to select the source of the information related to the material density (as percentage of the max value allowed by the machine): P_CM4: density from CM4 parameter; Ean2: ensity from Ean2 analog input (terminals XM1-30, 31) If: density from If analog input (terminal XM1-28, 31)
CM3	Set this parameter to select the source of the information related to the coil width (as percentage of the max value allowed by the machine): P_CM5: width from CM5 parameter Ean2: width from Ean2 analog input (terminals XM1-30, 31) Tach: width from Tach analog input (terminals XM1-26, 27) (Jumpers 8, 9, 10, 11, 12) If: width from If analog input (terminal XM1-28, 31)
CM4	Set to the density value when CM2= = P_CM4.
CM5	Set to the coil width value when CM3= = P_CM5.
CM6	Set to the machine acceleration time value (s) measured with the motorized cylinder
CM7	Set to the machine acceleration time value (s) measured in empty reel conditions.
CM8	Set to the machine acceleration time value (s) measured in max reel conditions.

E5.9.3 Maximum acceleration time calculation - Axial winder

$$CM7 = CM6 + \left[\left(T_c - CM6 \right) \cdot b_M \cdot d_M \cdot f(d)_M \right]$$ where:

$CM7(AccT_1)$	max reel acceleration time;
$CM6(AccT_0)$	empty reel acceleration time;
T_C	acceleration time measured with a convenient coil;
b_M	max width to convenient coil width ratio (≤1);
d_M	max density to material density of the convenient coil ratio (≤1);
$f(d)_M$	function of the diameter: $f(d)_M = \frac{\left(1 - d_o^4\right)}{\left(D_c^4 - d_o^4\right)}$ where:
	d_0 min diameter (as percentage of the max diameter, < 1);
	D_C convenient coil diameter (as percentage of the max diameter, ≤1).

E5.9.4 Maximum acceleration time calculation - Tangential reel

$$CM8 = CM6 + \left(CM7 - CM6 \right) \cdot \left\{ d_o^2 \cdot \left[1 - \frac{\left(1 - d_o^4\right)}{d_r \cdot b_r \cdot \left(D_c^4 - d_o^4\right)} \right] \right\} + \left(T_c - CM6 \right) \cdot \left[\frac{D_c^2 \cdot \left(1 - d_o^4\right)}{d_r \cdot b_r \cdot \left(D_c^4 - d_o^4\right)} \right]$$

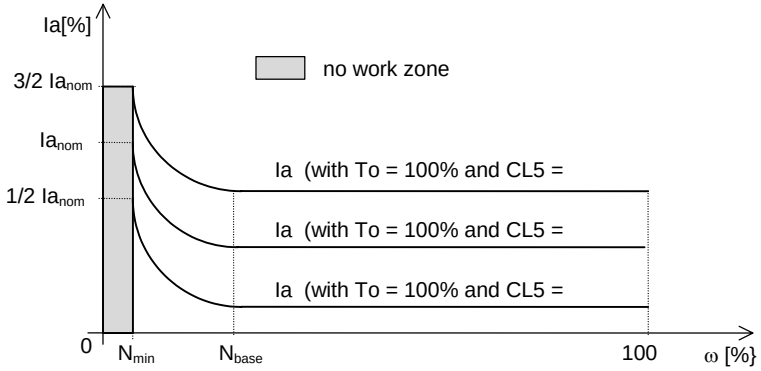
where:

CM8(AccT2)	max reel acceleration time;
CM7(AccT1)	empty reel and supported core acceleration time;
CM6(AccT0)	empty reel and without core acceleration time;
T_C	acceleration time measured with a convenient coil;
b_r	material width of the convenient coil related to the max width (≤1);
d_r	material density of the coil related to the max density (≤1);
D_C	convenient coil diameter (as percentage of the max diameter, ≤1);
d_0	min diameter (as percentage of the max diameter,<1).

E5.10 Tension Max - Range (Winder function)

In the usual conditions the max tension (To = 100%) is that the drive can supply in all working conditions and is the tension that the motor can supply with the nominal current and torque at the max diameter (DMax = 100%).

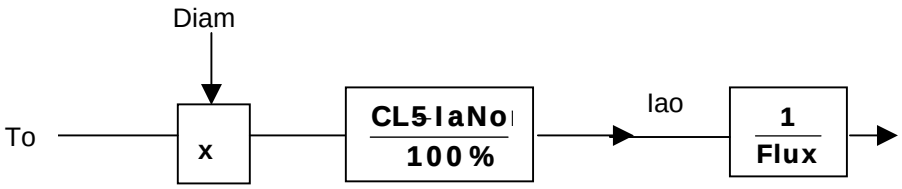
In some applications it is possible to accept short motor overload or to reduce the max tension of the machine, modyfing par. CL5 (as percentage of the motor nominal current). Par. CL5 is expressed as percentage of motor nominal current at the max diameter (DMax = 100%) when the tension reference is the maximum (To = 100%).



With a tension reference To = 100%:

- in the range between base-speed (NBase) and the max speed (N = 100%) when the diameter decreases the angular speed increases but the tension is constant with a constant armature current with a value less than the nominal one.
- in the range between minimum speed (Nmin) and the base-speed (NBase) when the diameter decreases the angular speed increases and the tension is constant while the armature current decreases.
- at the minimum speed we have the max diameter and the tension is constant while the armature current is maximum; the value can be calculated by the formula:

$$Ia[\%] = CL5 \cdot \frac{IaNom}{100}.$$



E5.11 Diagnostics

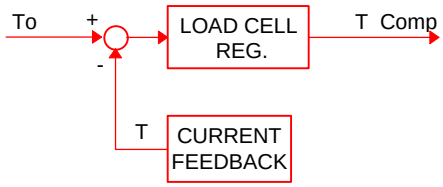
Most variable used within tension regulators (closed loop and open loop regulators) are readable programming the variables Aux1, Aux2 and Aux3 thru the DG5, DG6 and DG7 parameters.

We briefly show here the meaning of those auxiliary variables referring to the schemes described at the par. 8.3.1, 8.3.2, 8.3.3, 8.3.4, 7.3.5 and 7.3.6.

– ToRef Tension reference (%) after Taper function.



T_Comp Closed loop tension regulator output (load cell/dandy roll).

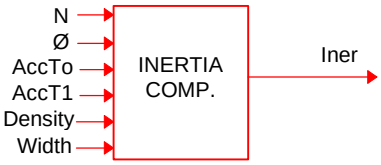


– DiamMeasured/Calculated Diameter (%).

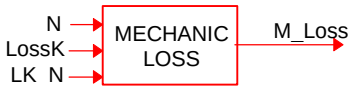
Iao_To "Tension Ref." block output.



Iner "Inertia Comp." block output.



M_Loss "Mechanic Loss" block output.



E6 PARAMETERS

E6.1 Configuration Parameters

Code	Name	Default	Values	Description
			Group G - POSITION REG.	
Note	this group includes the parameters of the Angular Position Regulator aux function.			
CGA 430.0	Enable	OFF	ON/OFF	Function enable.
CGB 430.1	PosSp	OFF	ON/OFF	Pulses suppression enable after the positioning.
CGC 430.2	PosFbk	OFF	ON/OFF	Enable the display of the rotor position; programm Aux1 or Aux2 or Aux3 with the value 'RotPos' (par. DG5, DG6 and DG7).
CG1 431B	K_Pos	0	0÷3	Re-calibration coefficient of the position references
CG2 432W	Acc_S	2 %	0.1÷100 %	Approaching speed in the positioning phase.
CG3 434W	PRefF	0	0÷9999	Forward angular position reference.
CG4 436W	PRefB	0	0÷9999	Reverse angular position reference
CG5 438W	P_Err	100	0÷9999	Maximum allowed position error.
			Group J - TENSION REG.	
Note	this group includes the parameters for the selection of the required tension regulator and for the setting of the references and of the tension feedback.			
CJA 450.0	T_En	OFF	ON/OFF	Enable of the tension regulator with load cell.
CJB 452B	W_En	OFF	ON/OFF	Enable of the open loop tension regulator (Winder).
CJC 450.2	Taper	OFF	ON/OFF	Taper function enable.
CJ1 451B	ToSel	P_CJ4		Selection of the tension reference source.
			M_Pot	Tension reference from software motopotentiometer.
			Rif	Tension reference from Rif analog input, terminals XM1-33, 34.
			Ean1	Tension reference from Ean1 analog input, terminals XM1-29, 31.
			P_CJ4	Tension reference from CJ4 parameter.
CJ2 452B	T_Sel	Serial		Selection of the tension feedback source.
			Serial	Tension feedback from serial link.
			Ean2	Tension feedback from Ean2 analog input, terminals XM1-30, 31.
			Tach	Tension feedback from Tach analog input, terminals XM1-26, 27.
CJ3 453B	ToN0S	Serial		Enable selection of the zero speed tension reference acquisition (the zero speed tension reference is set by CJ5 parameter).
			ToN0Of	Disabled acquisition.
			ToN0On	The acquisition of the zero speed tension reference occurs at zero speed.
			COM6	The acquisition of the zero speed tension reference occurs at the rising edge of COM6 logic command (available with the SPDIO hardware option).
			COM7	The acquisition of the zero speed tension reference occurs at the rising edge of COM7 logic command (available with the SPDIO hardware option).
CJ4 454W	ToRef	0	0÷100%	Tension reference value.
CJ5 456W	ToN=0	0	0÷100%	Zero speed tension reference value.
CJ6 458B	TapTy	Lin.		Selection of the waveform used to apply the Taper function.
			Lin	Linear Taper function.
			Hyp.	Hyperbolic Taper function.
CJ7 460B	TapDo	10%	0.1÷99.9%	Diameter value starting from which the Taper function begins.
CJ8 462W	Tap_V	50%	0÷100%	Value of the tension reference when the Taper function is enabled and the diameter reached the max value (100%).
CJ9 464W	TToN0	10s	0÷25s	Tension reference ramp time. All tension reference changes and all switching from zero speed tension reference to actual tension reference and vice versa are filtered through this ramp time. The value set on CJ9 actually matches the time expressed in seconds only if CD3 = 10ms. Otherwise, time can be calculated with the following formula: T[s] = CJ9 · CD3/ 10ms

Code	Name	Default	Values	Description
				Group H - BACKLASH COMP.
Note	this group includes the parameters for the backlash compensation function.			
CHA 498W	Enable	OFF	ON/OFF	Function enable.
CH1	B_Val	1.0%	0.1÷100%	It is, as absolute value, the value assumed by the current limits during the time set by CO2 parameter, after the bridge reversing.
CH2	BTime	10	1÷250	Time during which the current limits assume (with sign) the value set by CO1 parameter, after the bridge reversing (as tenth of milliseconds).
CH3	B_Rmp	10	1÷250	Time of the ramp used by the current limits to go from the value set by CO1 parameter to their starting value when the time set by CO3 parameter elapses (as tenth of ms).
				Group K - LOAD CELL REG.
Note	this group includes the parameters for the setting of the tension regulator with load cell.			
CKA 466.0	LC_F	OFF	ON/OFF	Load cell position in respect to the converter: OFF = the load cell is located before the converter; ON = the load cell is located after the converter.
CKB 466.1	TErr=0	OFF	ON/OFF	Tension regulator insertion mode: ON = regulator insertion with zero tension error.
CKC 466.2	Gi_Fix	OFF	ON/OFF	Mode of calculation of the tension regulator integral gain: OFF= the integral gain is calculated as speed function; ON= the integral gain is fixed and its value is set by TK2parameter.
CK1 467B	T_K	100	1÷255	Re-calibration of the tension regulator output; the tension regulator output is divided by the value set on this parameter.
CK2 468B	Appl	NLoop	NLoop	Selection of the application mode of the tension regulator with load cell. Application in correction to the speed regulator.
			ILoop	Application in correction to the current regulator (saturation of the speed regulator).
			Winder	Application in correction to the open loop tension regulator (Winder).
CK3 470B	K_Int	20%	0÷200%	Re-calibration of the integral gain of the tension regulator with load cell when it is calculated as speed function (parameter CKC = OFF).
				Group L - WINDER REG.
Note	this group includes the parameters for the setting of the open loop tension regulator (Winder).			
CL1 474B	Type	Axial	Axial	Selection of the open loop tension regulator type. Axial winder.
			Tang.	Tangential winder.
CL2 475B	W_Flt	20 rad/s	0÷255 rad/s	Cutoff frequency of the filter at the Winder regulator output. To disable CL2=0.
CL3 476B	W_Sel	Wind	Wind	Selection of the Winder operating mode. Winder
			Unwind	Unwinder
CL4 477B	Mat_P	Normal	Normal	Selection of the material passage mode Material passage in the normal setting.
			Rev	Material passage in the alternate setting.
			COM6	The material passage is given by the status of COM6 logic command (available with SPDIO): OFF = normal setting; ON = alternate setting.
CL5 478W	ToRic	100%	0÷200%	Recalibration of the armature current wanted at max tension and max diameter (% of rated armature current)
				Group M - INERTIA COMP.
Note	this group includes the parameters for the Inertia Compensation function.			
CMA 480.0	Enable	OFF	ON/OFF	Inertia Compensation function enable.
CM1 481B	Type	Const.	Const.	Selection of the inertia compensation type. Constant inertia compensation.
			Var.	Variable inertia compensation (Winder).
CM2 482B	DensS	P_CM4	P_CM4	Selection of the material density signal source. From CM4 parameter.
			Ean2	From Ean2 analog input, terminals XM1-30, 31.
			If	From If analog input, terminals XM1-28, 31.
CM3 483B	WdthS	P_CM5	P_CM5	Selection of the material width signal source. From CM5 parameter.
			Ean2	From Ean2 analog input, terminals XM1-30, 31.
			Tach	From Tach analog input, terminals XM1-26, 27.
			If	From If analog input, terminals XM1-28, 31.

Code	Name	Default	Values	Description
CM4 484W	Dens.	100%	0.1÷100%	Material density.
CM5 486W	Width	100%	0.1÷100%	Material width.
CM6 488W	AccTo	0	0÷999.9 s	First machine acceleration time.
CM7 490W	AccT1	100 s	0÷999.9 s	Second machine acceleration time.
CM8 492W	AccT2	100 s	0÷999.9 s	Third machine acceleration time.
				Group N - DIAMETER CALC.
Note	this group includes the parameters for the acquisition and the calculation of the diameter.			
CN1 498W	D_Min	10%	0.1÷100%	Minimum diameter.
CN2 501B	FDimS	P_CN3	P_CN3	Selection of the starting diameter source. From CN3 parameter.
			Ean1	From Ean1 analog input, terminals XM1-29, 31.
			Ean2	From Ean2 analog input, terminals XM1-30, 31.
CN3 502B	FDiam	10%	0.1÷100%	Starting diameter.
CN4 504W	CDThr	2%	0÷10%	Angular speed threshold before which the diameter calculation is disabled (parameter CN6=Calc.).
CN5 506B	DiamS	Off	Off	Selection of the operating diameter source. Diameter calculation disabled; the diameter value is assumed equal to CN1.
			Ean1	From Ean1 analog input, terminals XM1-29, 31.
			Ean2	From Ean2 analog input, terminals XM1-30, 31.
			Calc.	Calculated diameter
			Serial	From serial link.
CN6 510B	CDinh	0	0÷250	Disabling time of the diameter calculation function after the Start command.

E6.2 Tuning Parameters

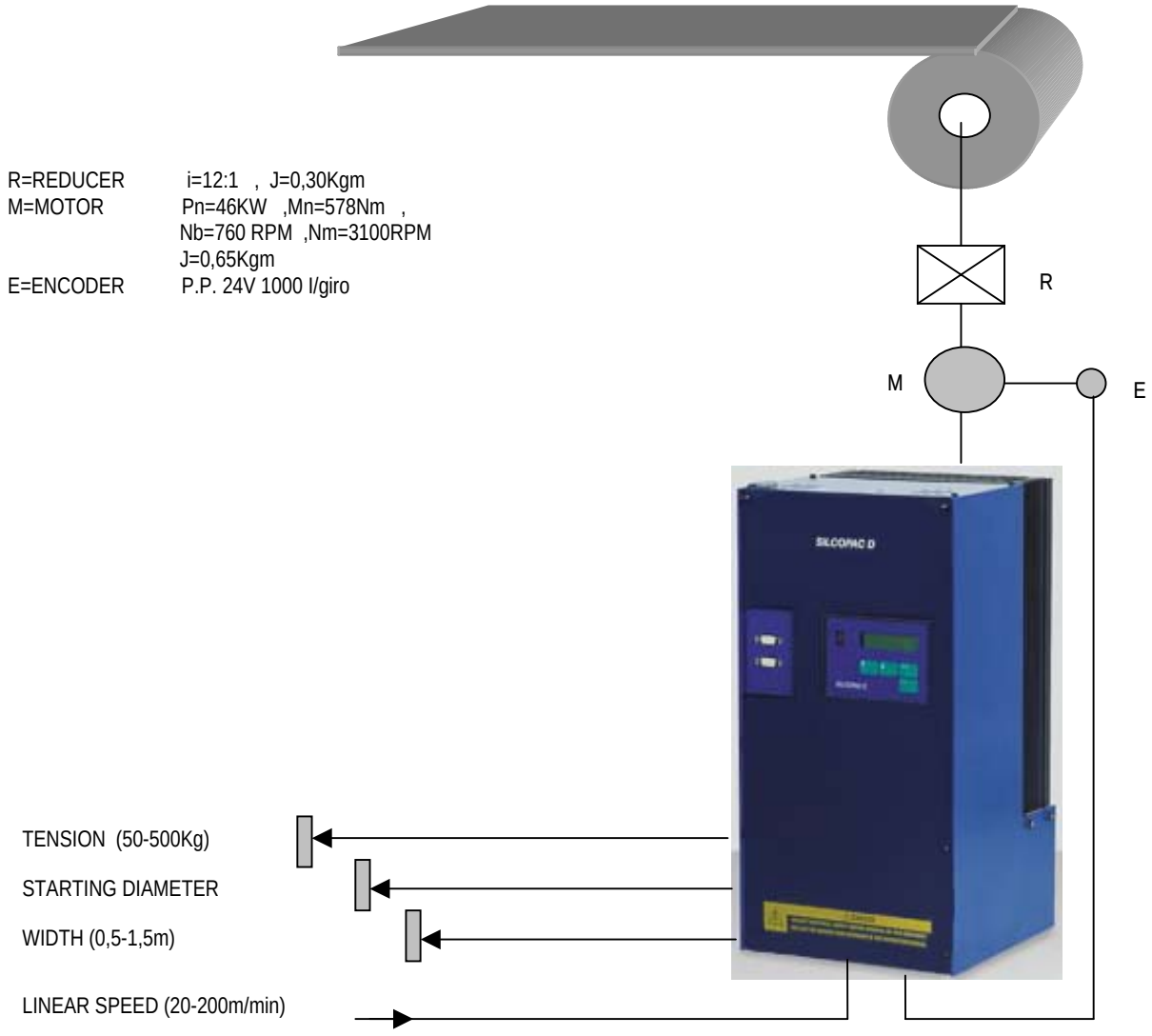
				Group J - POSITION REG.
Note	this group includes the parameters of the Angular Position Regulator aux function.			
TJ1 172W	GpPos	0	0÷9999	Proportional gain of the motor shaft position regulator.
TJ2 178B	TcFGi.	400	0÷9999	Proportional gain of the motor speed regulator after the positioning.
TJ3 W	TacRF	80	0÷8000	Integral gain of the motor speed regulator after the positioning.
TJ4 W	TdcRF.	0	0÷255	speed regulato lead-lag network (derivative section) after positioning. Filter typical frequencies have the following values: filter pole Wp = TJ4 / 20.48 rad/s filter zero Wz = TJ4 / 102.4 rad/s To disable the filter, set TJ4 = 0.
				Group K - LOAD CELL
Note	this group includes the parameters of the Adaptive Tension Regulator aux function.			
TK1 200W	Gp_T	100	1÷9999	Proportional gain of the tension regulator.
TK2 202W	Gi_T	100	0÷8000	Integral gain of the tension regulator.
TK3 204W	TLimT	2 %	0÷100 %	Positive limit of the tension regulator output.
TK4 206W	TLimB	-2 %	-100 %÷0	Negative limit of the tension regulator output.
TK5 208W	NoLmT	+100%	0÷+120%	Forward limit of the speed regulator after the tension regulator correction (active only when the regulator is enabled by command Com3=ON).
TK6 210W	NoLmB	-100%	-120%÷0	Reverse limit of the speed regulator after the tension regulator correction (active only when the regulator is enabled by command Com3=ON).
TK7 212W	Gd_T	0	0÷255	lead-lag network (derivative section) on the TENSION regulator feedback. Filter typical frequencies have the following values: filter pole Wp = TK7 / 20.48 rad/s filter zero Wz = TK7 / 102.4 rad/s To disable the filter, set TK7 = 0.

APPLICATION EXAMPLES

AXIAL WINDER WITH INDIRECT TENSION CONTROL

We suppose to program a SPDM that controls a winder with the following characteristics:

Quantity	Symbol	Value
Linear speed	Vl	200m/min (3,33m/s)
Coil core diameter	Do	0,5m
Coil core internal diameter	d1	0,48m
Maximum diamete of coil	Dm	2m
Minimum material width.	Lo	0,5m
Maximum material width.	Lm	1,5m
Coil core length	L	2m
Material minimum thickness	So	0,3mm
Material maximum thickness	Sm	5mm
Acceleration time	Tal	20s
Starting diameter for TAPER function		1m
Value of TAPER function at max diameter		70%
Zero speed tension		20%
Tension setted by the user		By potentiometer
Passage of the material		Normal



PARAMETER CONFIGURATION

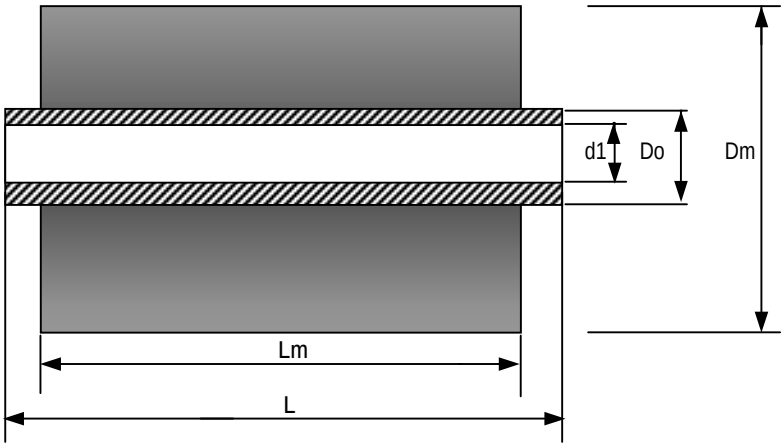
Parametero	Value	Function
CJB	ON	I enable the indirect tension regulator function
CJ1	Ean1	I select the source of the tension set
CJ4	Default	Not used
CL1	Axial	It is an axial winder
CL2	0	
CL3	Wind	It is a wind
CL4	Normal	The material passage is normal
CL5	100%	
CB2	Aux Add	I add a value (CE1) to the speed reference so to saturate the speed regulator
CE1	10%	
CA2	Aux Ric	Current limits impoosed by tension regulator
A. TAPER FUNCTION		
CJC	ON	I enable the function
CJ6	Lin	
CJ7	50%	I set the starting diameter
CJ8	70%	I set the tension value at maximum diameter
B. INERTIA COMPENSATION		
CMA	ON	I enable the function
CM1	Var	Inertia compensation calculated as a function of diametro
CM2	P-CM4	Material density (in this case we suppose that that material is always the same)
CM3	Tach	Material width (10V=maximum width)
CM4	100%	See CM2
CM5	100%	Default
CM6	**	Acceleration time with core coil
CM7	***	Acceleration time with full coil
CM8	Default	Not used (axial winder)
CJ3	ToNoON	Acquisition of the zero speed tension reference
CJ4	Default	
CJ5	20%	Zero speed tension value
CN1	25%	Do/Dm*100
CN2	Ean2	Source of the starting diameter setted by the user
CN3	Default	
CN4	10%	Threshold speed under that the diameter is not calculated
CN5	Calc	Selection of the operating diameter source.
CN6	0	Disabling time of the diameter calculation function after the Start command.
CED	ON	I enable the mechanical frictions compensation function
CE3	10%	Constant mechanical frictions compensation value
CE4	10%	Variable mechanical frictions compensation value
CA3	Aux Add	Term to add to the armature current reference (frictions)

Note. Since it is necessary to set tension regulator, starting diameter, material width, so to make available the analog input Tach (terminal 26) we must use an encoder as speed transducer.

THE ACCELERATION TIME IS OBTAINED BY THE FOLLOWING FORMULA :

$ta = Jt \frac{\Delta \omega}{Ma}$ [s] where	$Jt = Jmotore + Jriduttore + \frac{Jcarico}{i^2}$ [Kgm²]
	Ma =ACCELERATION TORQUE [Nm

LOAD INERTIA CALCULATION



a)	CORE COIL	$Jn = L*\Pi\frac{Do^2}{4}yo\frac{Do^2}{8} - L*\Pi\frac{d1^2}{4}yo\frac{d1^2}{8} = \frac{\Pi}{32}L*yo*(Do^4 - d1^4)$
b)	FULL COIL	$Jav = Lm*\Pi\frac{Dm^2}{4}y1\frac{Dm^2}{8} - Lm*\Pi\frac{Do^2}{4}y1\frac{Do^2}{8} + Jn$
		$Jav = \frac{\Pi}{32}[Lm*y1*(Dm^4 - Do^4) + L*yo*(Do^4 - d1^4)$

In our case, supposing sheet working material and iron core we will have:

yo = y1 = density = 7,81 $\frac{Kg}{dm^3}$	Jrv=14,44 Kgm² Jrp=18344,41 Kgm²

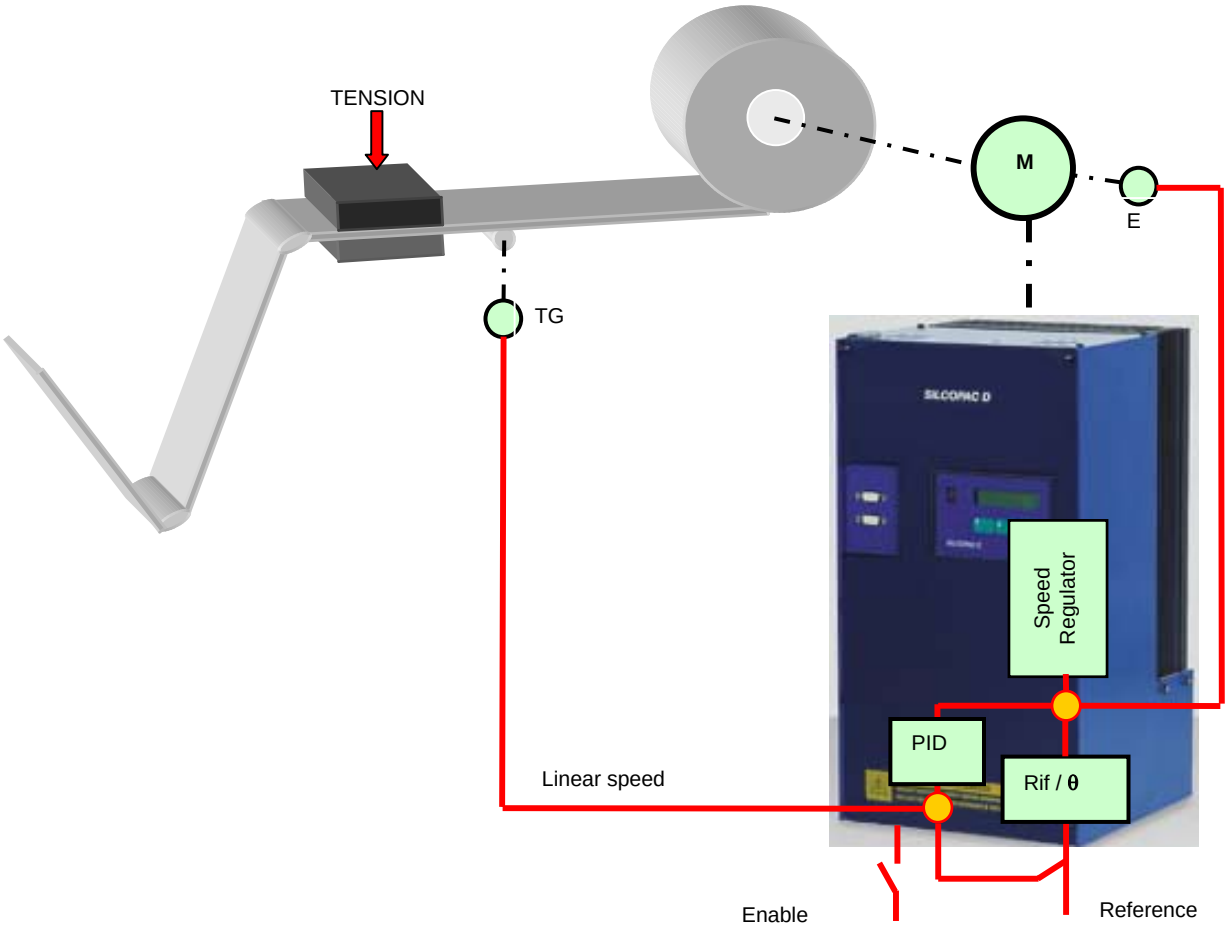
ACCELERATION TIME WITH CORE COIL FROM ZERO SPEED TO MOTOR BASE SPEED.	$Ta1 = CM6 = Jt1\frac{2\Pi*Nb}{60}\frac{1}{Mn} = 0{,}145s$
ACCELERATION TIME WITH FULL COIL	$Ta2 = CM7 = Jt2\frac{2\Pi*Nb}{60}\frac{1}{Mn} = 17{,}67s$

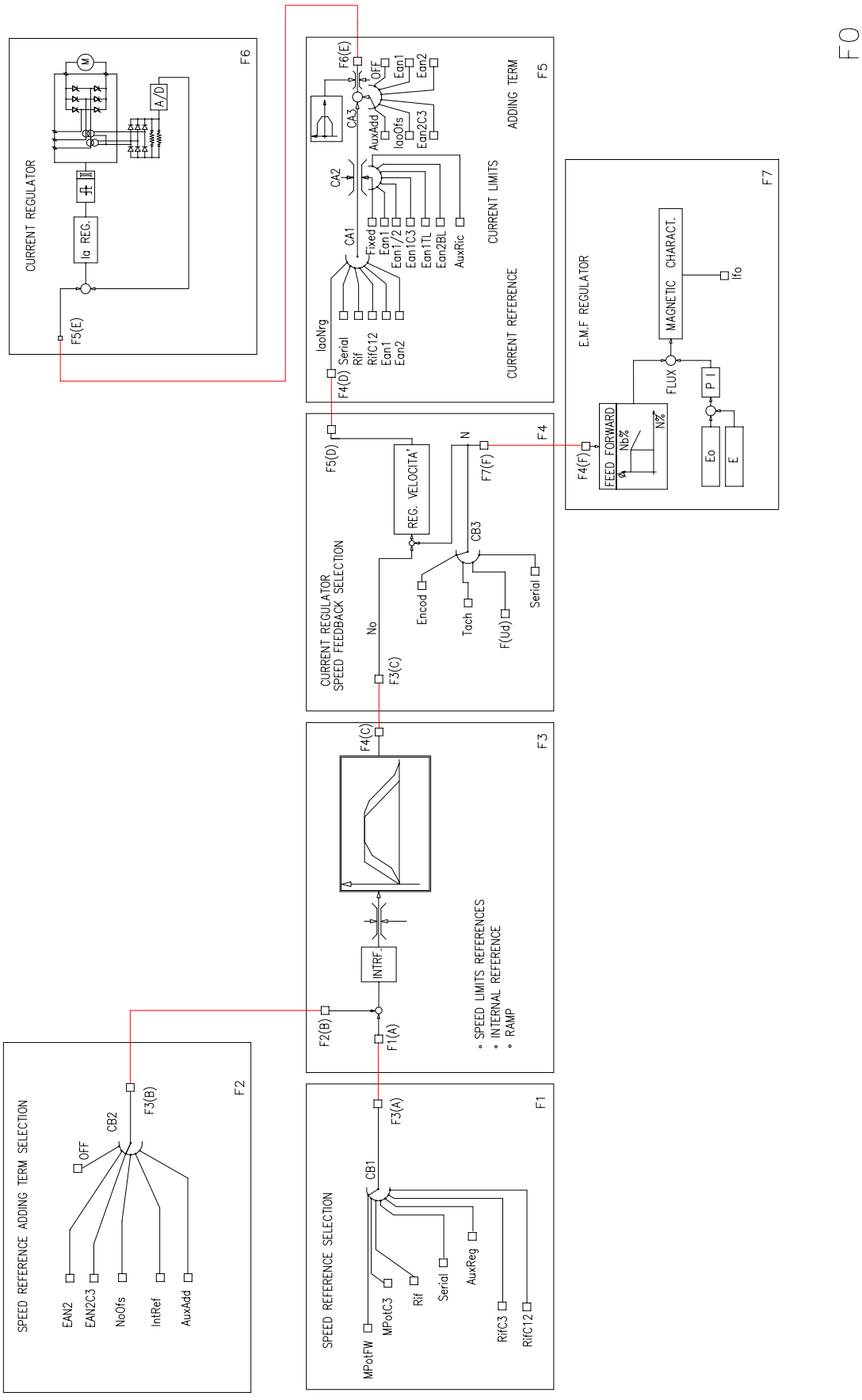
CM6 and CM7 may be obtained too with practice method showed at paragraph 5 of this section.

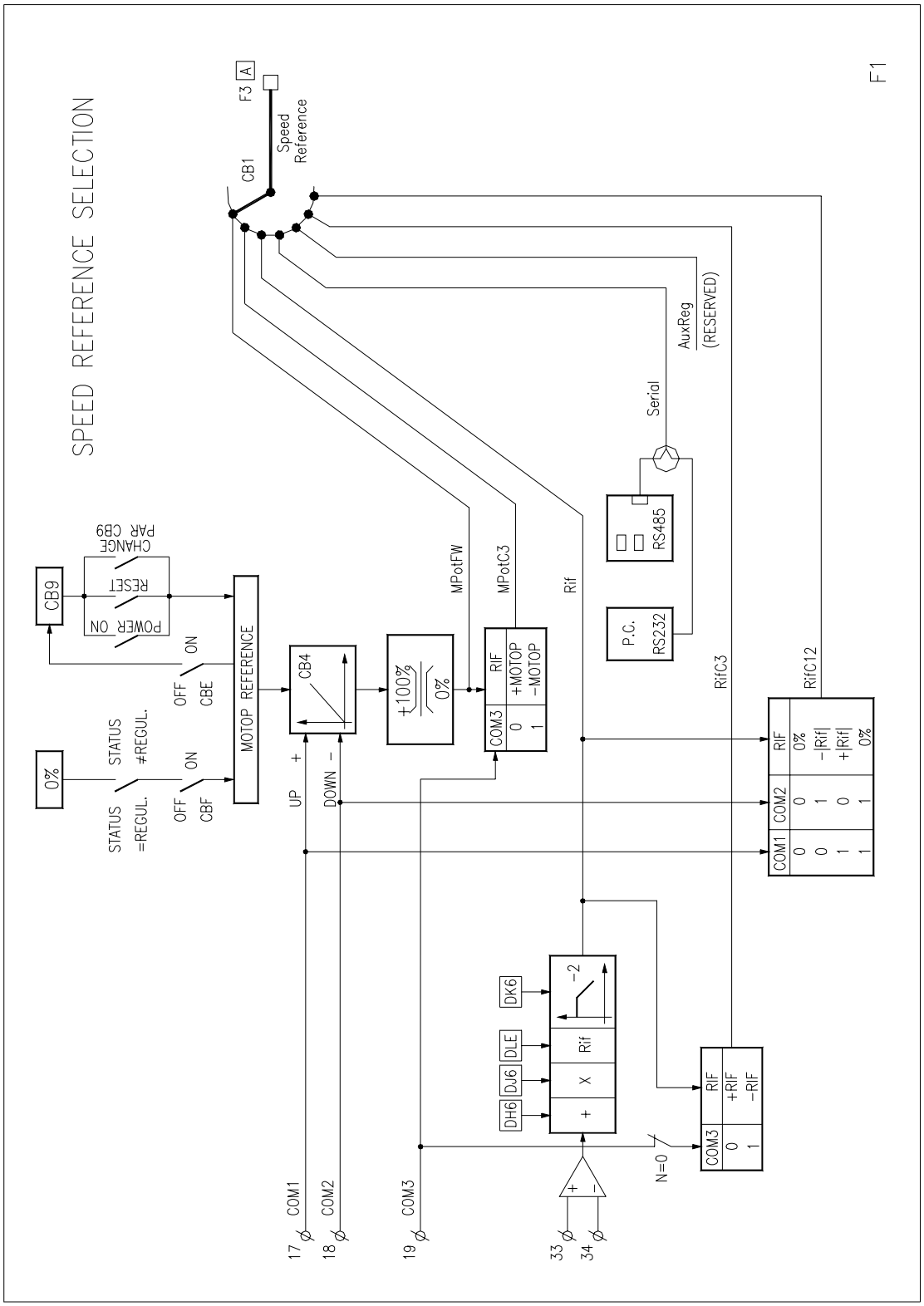
AXIAL WINDER: LINEAR SPEED REGULATION

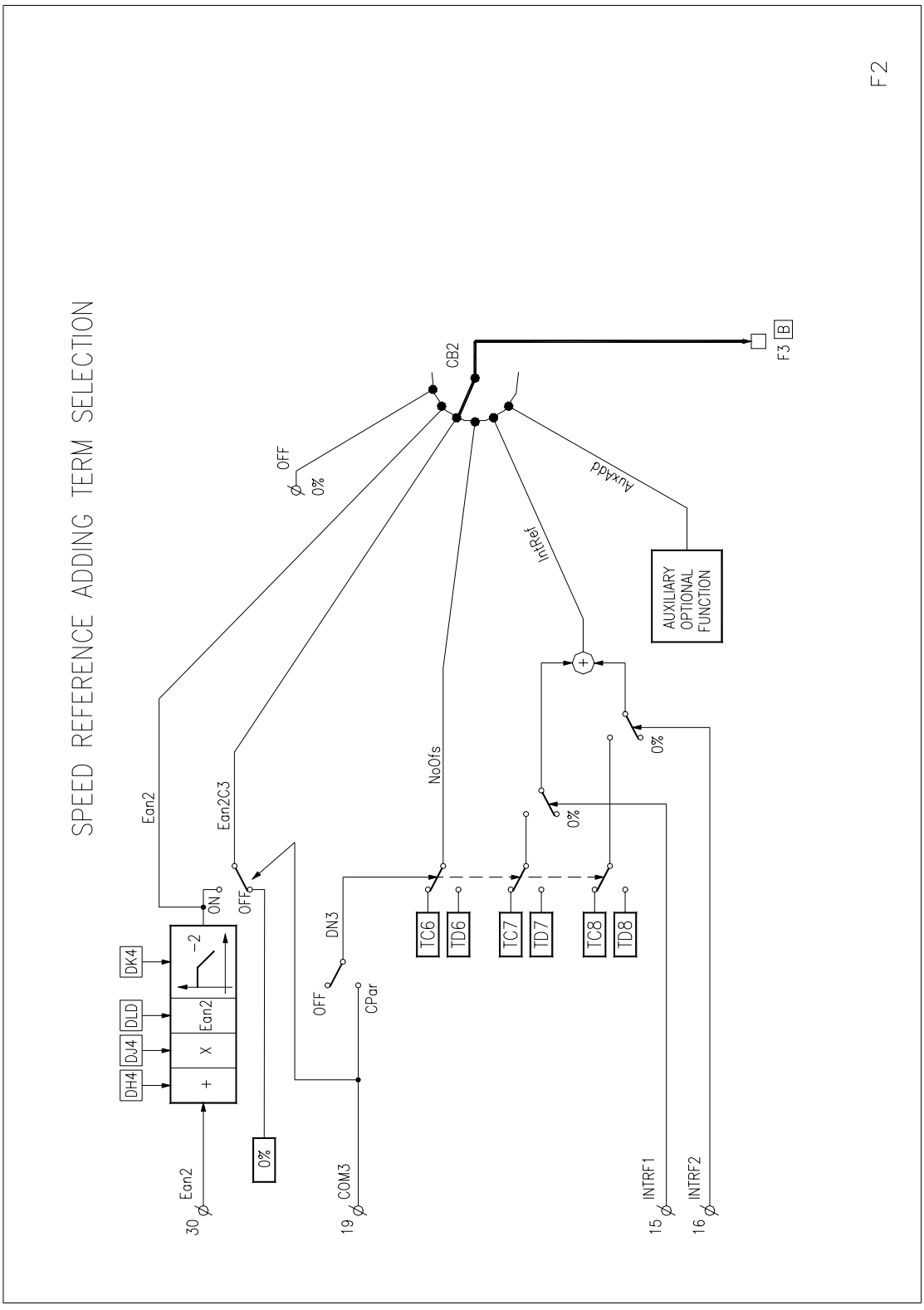
Program:

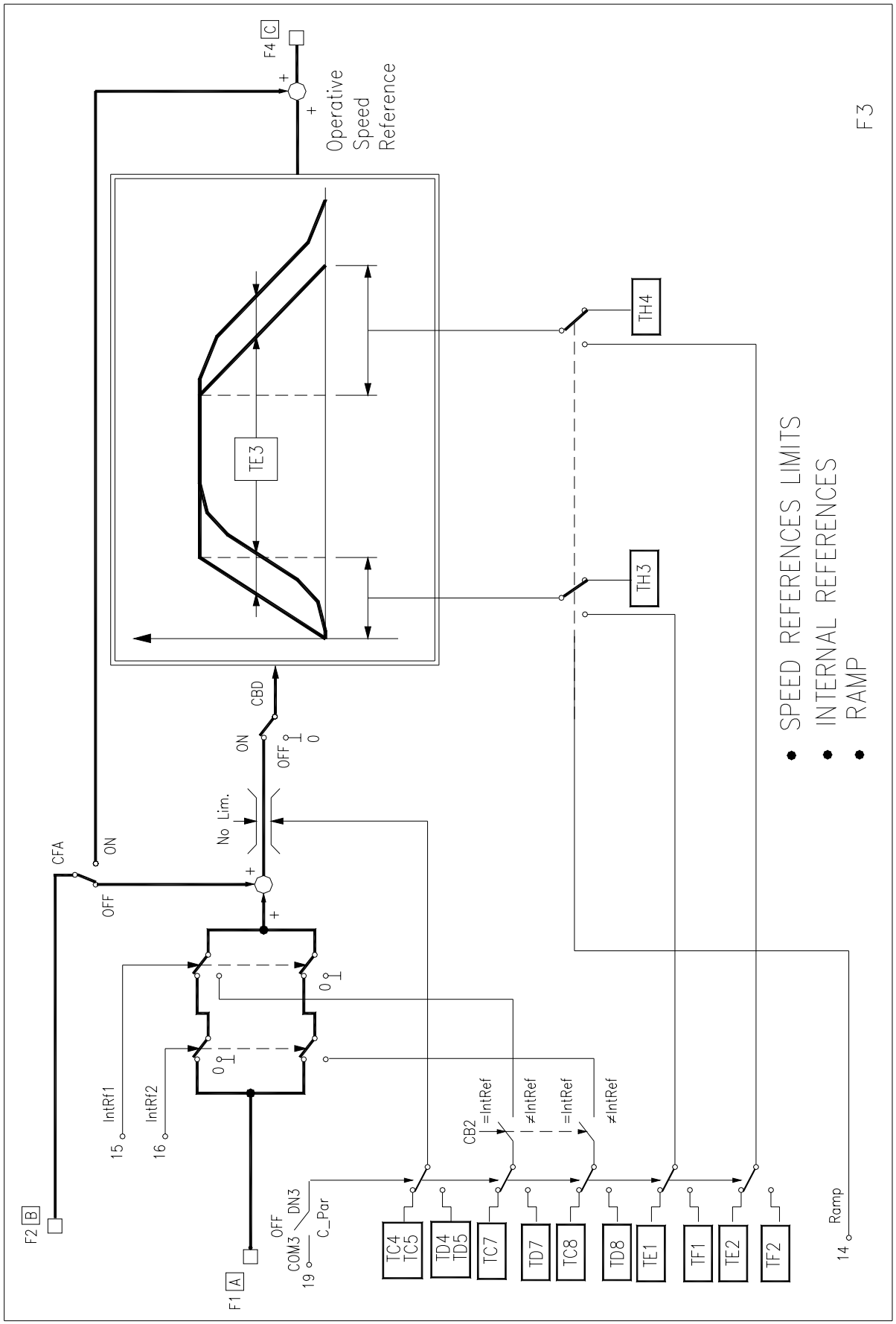
DMA=OFF	CN1=	♦The function is enabled closing COM3 (XM1-19 terminjal). ♦In JOG Start (equipment preparing and/or tail end of the material winding) COM3 must be opened. ♦The starting diameter is acquired at the rising edge of COM2.
JA=ON	CN2=	
CJ1=Ean1	CN3=	
CJ2=Ean2	CN4=	
CJ4=0.0	CN5=	
CJB=OFF	CN6=Calc	
CJC==OFF	TK1=10	
CJ3=ToNooF	TK2=15	
CJ5=0.0	TK3=10	
CJ9=1	TK4=-10	
CKA=OFF	TK5=100	
CKB=ON	TK6=-100	
CKC=ON	TK7=0	
CK1=1	CMA=Enable	
CK2=Nloop	CM1=Var.	
CB2=AuxAdd	CM2=P-CM4	
DM1=Aux1	CM3=P-CM5	
DG5=Diam	CM6=	
CBH=ON	CM7=	

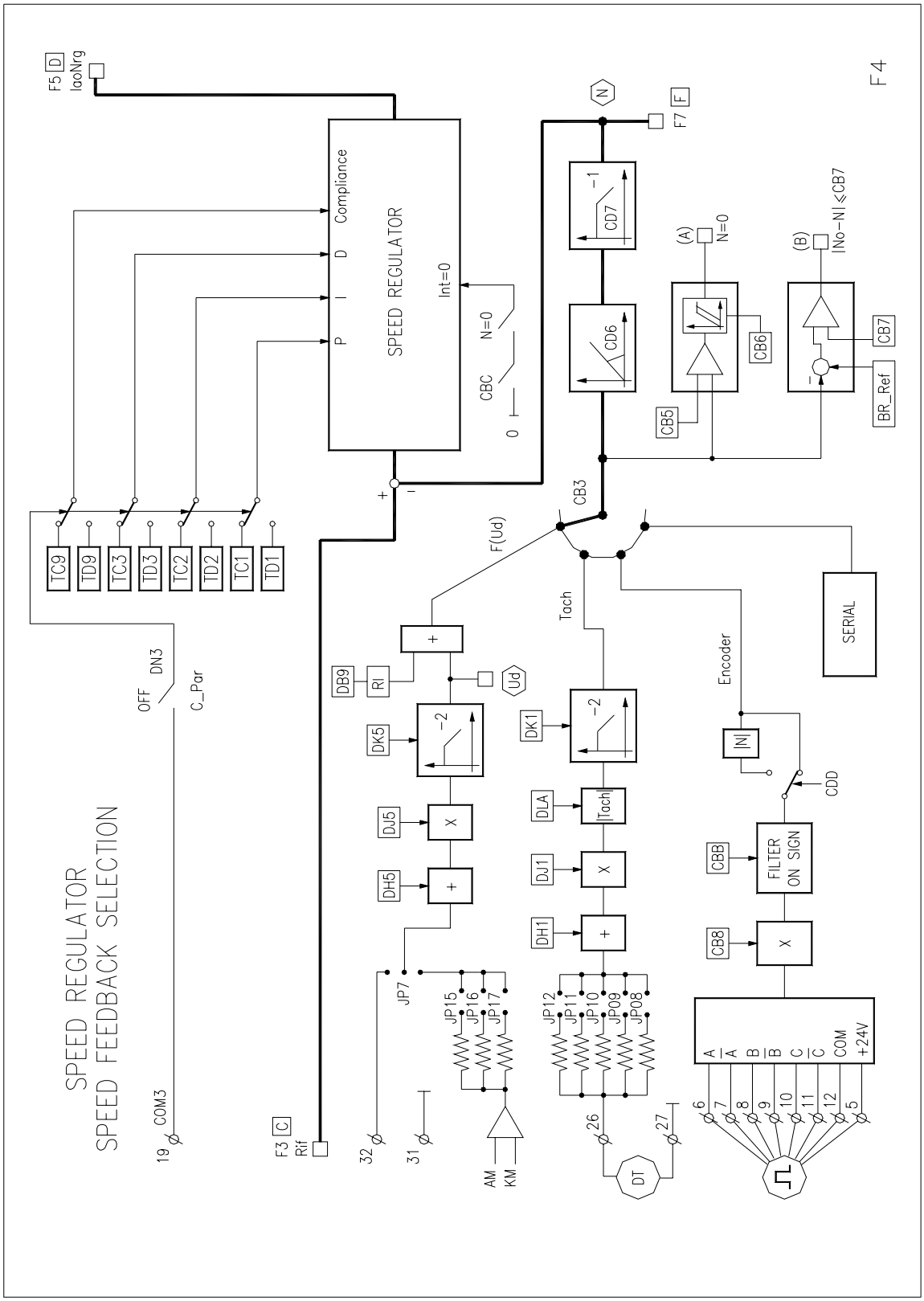


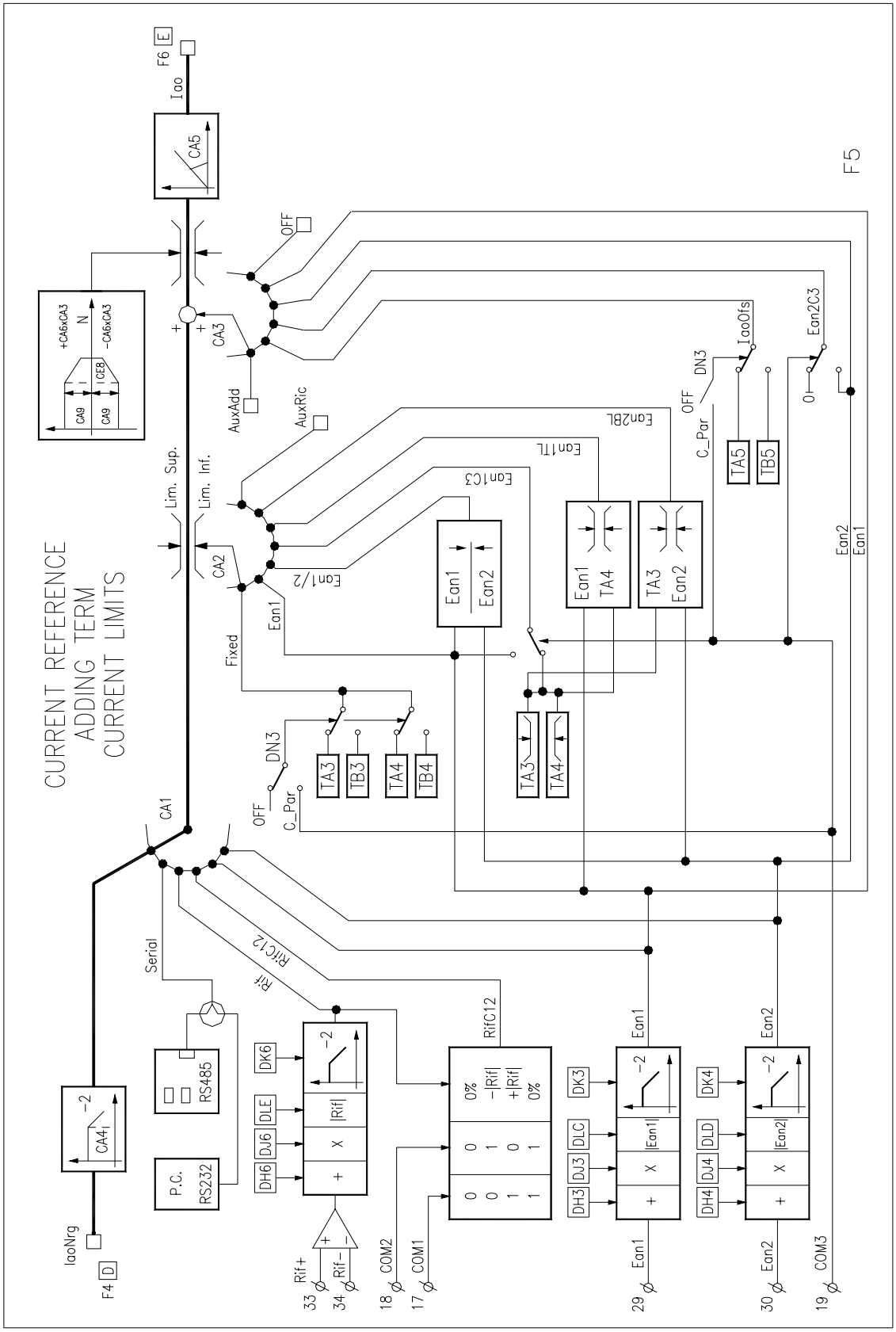

F0
F6
CURRENT REGULATOR
A/D
Ia REG.
F5(E)
F5
ADDING TERM
F6(E)
OFF
Ean1
Ean2
CA3
AuxAdd
IaoOfs
Ean2C3
CA2
CA1
Fixed
Ean1
Ean1/2
Ean1C3
Ean1TL
Ean2BL
AuxRic
CURRENT LIMITS
IaoNrg
Serial
Rif
RifC12
Ean1
Ean2
F4(D)
CURRENT REFERENCE
F7
E.M.F REGULATOR
MAGNETIC CHARACT.
Ifo
FLUX
P I
Eo
E
F4(F)
FEED FORWARD
Nb%
N%
F4
CURRENT REGULATOR
SPEED FEEDBACK SELECTION
F5(D)
REG. VELOCITA'
N
F7(F)
CB3
Encod
Tach
F(Ud)
Serial
No
F3(C)
F3
F4(C)
INTRF.
F2(B)
F1(A)
• SPEED LIMITS REFERENCES
• INTERNAL REFERENCE
• RAMP
F2
SPEED REFERENCE ADDING TERM SELECTION
OFF
CB2
F3(B)
EAN2
EAN2C3
NoOfs
IntRef
AuxAdd
F1
SPEED REFERENCE SELECTION
CB1
F3(A)
MPotFW
MPotC3
Rif
Serial
AuxReg
RifC3
RifC12

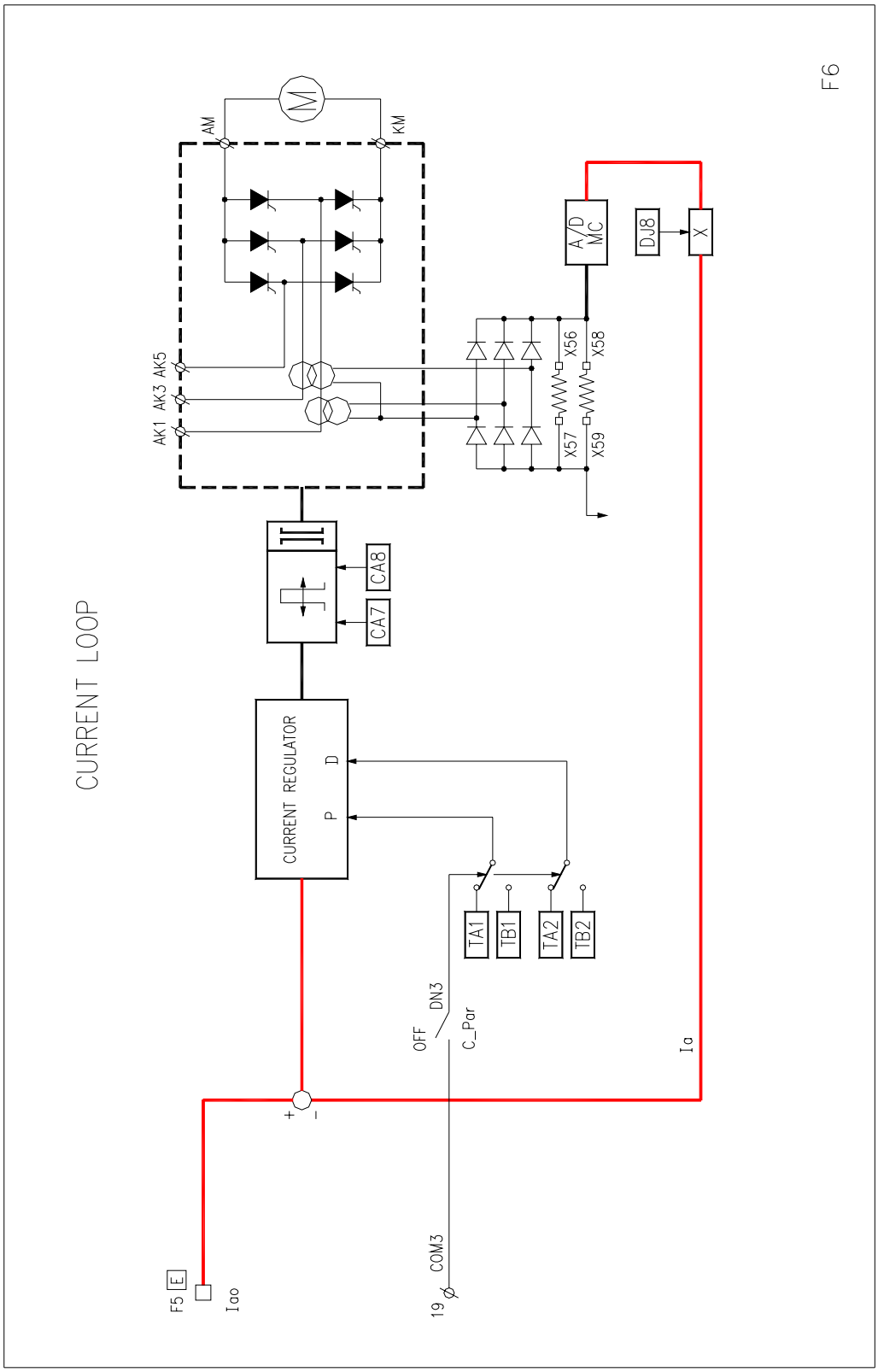

SPEED REFERENCE SELECTION
F1
F3 A
Speed Reference
CB1
AuxReg
(RESERVED)
Serial
RS485
P.C.
RS232
MPotFW
MPotC3
Rif
RifC3
RifC12
CB9
CHANGE PAR CB9
RESET
POWER ON
ON
OFF CBE
0%
STATUS ≠REGUL.
STATUS =REGUL.
ON
OFF CBF
MOTOP REFERENCE
CB4
UP +
DOWN –
±100%
0%
RIF
+MOTOP
–MOTOP
COM3
0
1
RIF
0%
–|Rif|
+|Rif|
0%
COM2
COM1
DK6
DLE
DJ6
DH6
–2
Rif
X
+
RIF
+RIF
–RIF
N=0
COM1
COM2
COM3
17
18
19
33
34

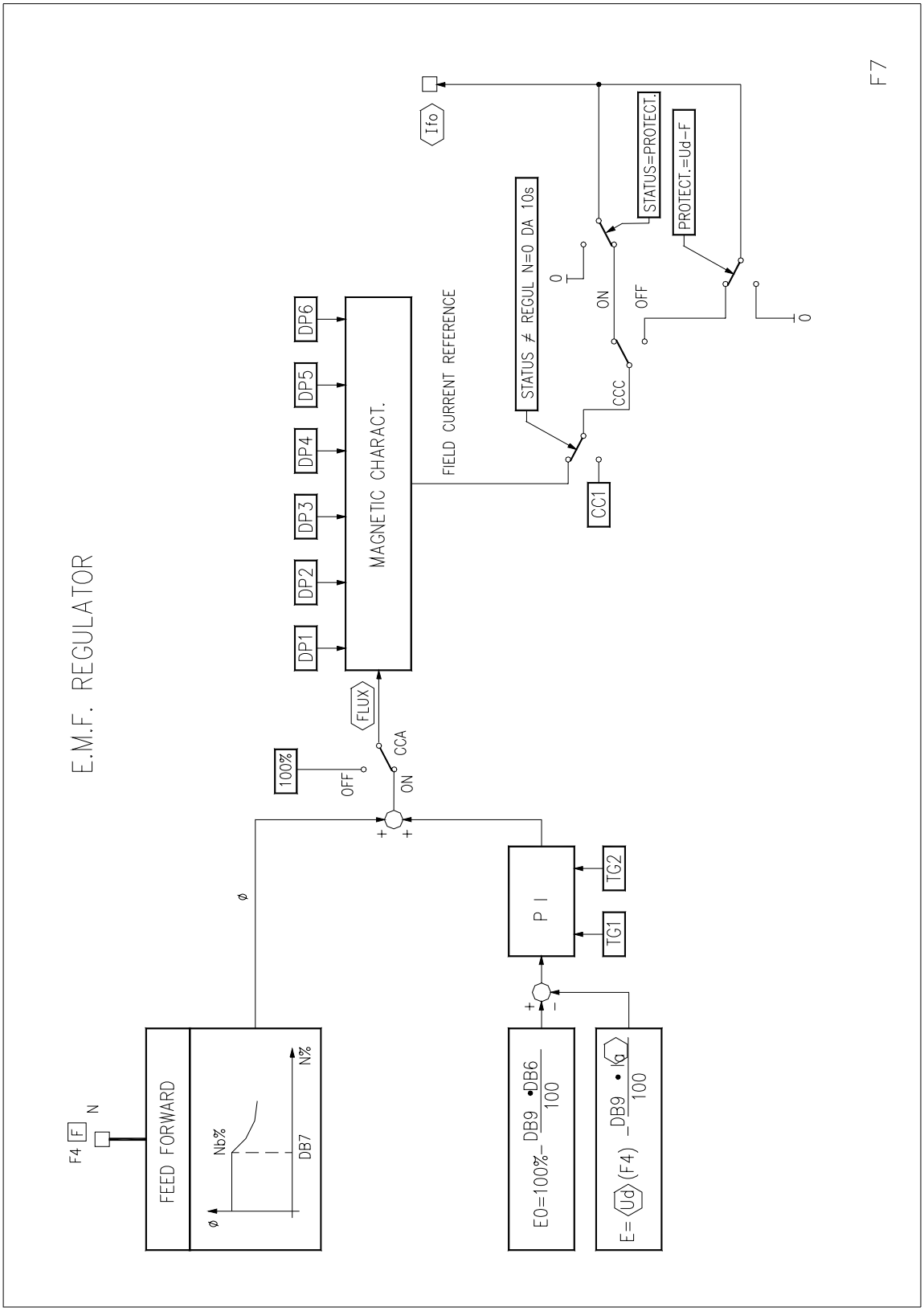

SPEED REFERENCE ADDING TERM SELECTION
F2
CB2
F3 B
OFF
0%
Auxadd
IntRef
AUXILIARY OPTIONAL FUNCTION
Ean2
Ean2C3
NoOfs
ON
OFF
DN3
OFF
CPar
TC6
TD6
TC7
TD7
TC8
TD8
0%
0%
0%
DK4
DLD
DJ4
DH4
-2
Ean2
X
+
Ean2
30
0%
COM3
19
INTRF1
15
INTRF2
16


F3
SPEED REFERENCES LIMITS
INTERNAL REFERENCES
RAMP
F4 C
+
+
Operative
Speed
Reference
TE3
TH4
TH3
CBD
ON
OFF
0
No Lim.
CFA
ON
OFF
+
+
0
0
0
IntRf1
IntRf2
15
16
CB2
=IntRef
≠IntRef
=IntRef
≠IntRef
F2 B
F1 A
OFF
COM3
DN3
C_Par
19
TC4
TC5
TD4
TD5
TC7
TD7
TC8
TD8
TE1
TF1
TE2
TF2
Ramp
14


F 4
SPEED REGULATOR
SPEED FEEDBACK SELECTION
F5 D
IooNrg
SPEED REGULATOR
P I D Compliance
Int=0
CBC N=0
0
N
F7 F
CD7
CD6
(A) N=0
CB6
CB5
(B) |No-N| ≤CB7
CB7
BR_Ref
CB3
F(Ud)
Tach
Encoder
SERIAL
TC9 TD9 TC3 TD3 TC2 TD2 TC1 TD1
OFF DN3
C_Par
COM3
19
F3 C
Rif
DB9 RI
Ud
DK5 -2
DJ5 X
DH5 +
JP7
32
31
JP15 JP16 JP17
AM KM
DK1 -2
DJA |Tach|
DJ1 X
DH1 +
JP12 JP11 JP10 JP09 JP08
26
27
DT
|N|
CDD
CBB FILTER ON SIGN
CB8 X
A A B B C C COM +24V
6 7 8 9 10 11 12 5


CURRENT REFERENCE
ADDING TERM
CURRENT LIMITS
F5
F6 E
Iao
CA5
OFF
CA3
AuxAdd
AuxRic
+CA6xCA3
N
-CA6xCA3
CA9
CE8
CA9
Lim. Sup.
Lim. Inf.
CA2
Ean1/2
Ean1C3
Ean1TL
Ean2BL
Fixed
Ean1
Ean1
Ean2
TA4
TA3
Ean2
Ean1
Ean2
DN3
C_Par
OFF
IaoOfs
Ean2C3
TA5
TB5
TA3
TB3
TA4
TB4
TA3
TA4
DN3
OFF
C_Par
CA1
Serial
Rif
RifC12
RS485
P.C.
RS232
CA4
IaoNrg
F4 D
DK6
DLE
DJ6
DH6
Rif
DK3
DLC
DJ3
DH3
Ean1
DK4
DLD
DJ4
DH4
Ean2
Rif+
Rif-
33
34
COM2
18
COM1
17
29
Ean1
30
Ean2
19
COM3


F6
CURRENT LOOP
AM
KM
AK1 AK3 AK5
A/D MC
DJ8
X
X56
X58
X57
X59
CA8
CA7
CURRENT REGULATOR
P D
TA1
TB1
TA2
TB2
OFF
DN3
C_Par
Ia
+
-
F5 E
Iao
COM3
19


F7
E.M.F. REGULATOR
Ifo
STATUS=PROTECT.
PROTECT.=Ud-F
STATUS ≠ REGUL N=0 DA 10s
0
ON
OFF
CCC
CC1
0
FIELD CURRENT REFERENCE
DP6
DP5
DP4
DP3
DP2
DP1
MAGNETIC CHARACT.
FLUX
100%
OFF
ON
CCA
+
+
ø
P I
TG2
TG1
+
-
F4 F N
FEED FORWARD
Nb%
DB7
N%
ø
E0=100%- DB9 •DB6 / 100
E= Ud (F4) - DB9 • Kσ / 100

APPENDIX B

DRIVE TRACE

N	STATUS PROTECTIONS	LOGIC I/O	Auxl	Aux2	Aux3	No	N	Iao	Ia	Ud	Flu	Ifo	If	Uvo	Alfa
- 24	REGUL.0000000000000000	1100001000011000	0110	+ 0.0	- 0.0	+ 33.4	+ 33.5	+ 1.9	+ 1.7 +	33.7	+100.0	+100.0	+115.8 +	98.7	+100
- 23	REGUL.0000000000000000	1100001000011000	0110	+ 0.0	- 0.0	+ 33.4	+ 33.5	+ 1.7	+ 1.7 +	33.7	+100.0	+100.0	+115.9 +	98.4	+100
- 22	REGUL-0000000000000000	1100001000011000	0110	+ 0.0	- 0.0	+ 33.4	+ 33.5	+ 1.8	+ 1.7 +	33.7	+100.0	+100.0	+115.9 +	98.7	+100
- 21	REGUL.0000000000000000	1100001000011000	0110	+ 0.0	- 0.0	+ 33.4	+ 33.5	+ 1.6	+ 1.7 +	33.7	+100.0	+100.0	+115.9 +	98.4	+100
- 20	REGUL-0000000000000000	1100001000011000	0110	+ 0.0	- 0.0	+ 33.4	+ 33.5	+ 1.8	+ 7 +	33.7	+100.0	+100.0	+115.9 +	98.7	+100
- 19	REGUL.0000000000000000	1100001000011000	0110	+ 0.0	- 0.0	+ 33.4	+ 33.5	+ 1.6	+ 1.7 +	33.7	+100.0	+100.0	+115.9 +	98.4	+100
- 18	REGUL.0000000000000000	1100001000011000	0110	+ 0.0	- 0.0	+ 33.4	+ 33.5	+ 1.8	+ 1.7 +	33.7	+100.0	+100.0	+115.9 +	98.7	+100
- 17	REGUL.0000000000000000	1100001000011000	0110	+ 0.0	- 0.0	+ 33.4	+ 33.5	+ 1.7	+ 1.7 +	33.7	+100.0	+100.0	+115.9 +	98.4	+100
- 16	REGUL.0000000000000000	1100001000011000	0110	+ 0.0	- 0.0	+ 33.4	+ 33.5	+ 1.8	+ 1.7 +	33.7	+100.0	+100.0	+115.9 +	98.7	+100
- 15	REGUL.0000000000000000	1100001000011000	0110	+ 0.0	- 0.0	+ 33.4	+ 33.5	+ 1.6	+ 1.7 +	33.7	+100.0	+100.0	+115.9 +	98.4	+100
- 14	REGUL.0000000000000000	1100001000011000	0110	+ 0.0	- 0.0	+ 33.4	+ 33.5	+ 1.8	+ 1.7 +	33.7	+100.0	+100.0	+115.9 +	98.7	+100
- 13	REGUL.0000000000000000	1100001000011000	0110	+ 0.0	- 0.0	+ 33.4	+ 33.5	+ 1.6	+ 1.7 +	33.7	+100.0	+100.0	+115.9 +	98.4	+100
- 12	REGUL.0000000000000000	1100001000011000	0110	+ 0.0	- 0.0	+ 33.5	+ 33.5	+ 1.8	+ 1.7 +	33.7	+100.0	+100.0	+115.9 +	98.7	+100
- 11	REGUL.0000000000000000	1100001000011000	0110	+ 0.0	- 0.0	+ 33.5	+ 33.5	+ 1.8	+ 1.6 +	33.7	+100.0	+100.0	+115.9 +	98.4	+100
- 10	REGUL.0000000000000000	1100001000011000	0110	+ 0.0	- 0.0	+ 33.4	+ 33.5	+ 1.8	+ 1.7 +	33.7	+100.0	+100.0	+115.9 +	98.7	+100
- 9	REGUL.0000000000000000	1100001000011000	0110	+ 0.0	- 0.0	+ 33.5	+ 33.5	+ 1.7	+ 1.7 +	33.7	100.0	+100.0	+115.8 +	98.4	+100
- 8	REGUL.0000000000000000	1100001000011000	0110	+ 0.0	- 0.0	+ 33.4	+ 33.5	+ 1.9	+ 1.7 +	33.7	+100.0	+100.0	+115.8 +	98.7	+100
- 7	REGUL.0000000000000000	1100001000011000	0110	+ 0.0	- 0.0	+ 33.4	+ 33.5	+ 1.7	+ 1.7 +	33.7	+100.0	+100.0	+115.8 +	98.4	+100
- 6	REGUL.0000000000000000	1100001000011000	0110	+ 0.0	- 0.2	+ 33.4	+ 33.5	+ 1.8	+ 1.7 +	33.7	+100.0	+100.0	+115.8 +	98.7	+100
- 5	REGUL.0000000000000000	1100001000011000	0110	+ 0.0	- 0.2	+ 33.5	+ 33.5	+ 1.7	+ 1.7 +	33.7	+100.0	+100.0	+115.8 +	98.4	+100
- 4	REGUL.0000000000000000	1100001000011000	0110	+ 0.0	- 0.2	+ 33.4	+ 33.5	+ 1.9	+ 1.7 +	33.7	+100.0	+100.0	+115.9 +	98.7	+100
- 3	REGUL.0000000000000000	1100001000011000	0110	+ 0.0	- 0.0	+ 33.5	+ 33,5	+ 1.7	+ 1.7 +	33.7	+100.0	+100.0	+115.9 +	98.4	+100
- 2	REGUL.0000000000000000	1100001000011000	0110	+ 0.0	- 0.0	+ 33.4	+ 33.5	+ 1.9	+ 1.7 +	33.7	+100.0	+100.0	+115.9 +	98.7	+100
- 1	REGUL.0000000000000000	1100001000011000	0110	+ 0.0	- 0.0	+ 33.4	+ 33.5	+ 1.6	+ 1.7 +	33.7	+100.0	+100.0	+115.9 +	98.4	+100
0	PROTE.0100000000000000	1100001000011000	0100	+ 0.0	- 0.0	+ 33.4	+ 33.5	+ 0.0	+ 1.7 +	33.7	+100.0	+100.0	+115.9 +	98.7	+100
+ 1	PROTE.0100000000000000	1100001000011000	0100	+ 0.0	- 0.0	+ 33.4	+ 33.2	+ 0.0	+ 1.7 +	33.4	+100.0	+100.0	+115.9 +	98.2	+165
+ 2	PROTE.0100000000000000	1100001000011000	0000	+ 0.0	- 0.0	+ 33.3	+ 33.4	+ 0.0	+ 0.0 +	33.4	+100.0	+100.0	+115.9 +	98.4	+165
+ 3	PROTE.0100000000000000	1100001000011000	0000	+ 0.0	- 0.0	+ 33.3	+ 33.1	+ 0.0	+ 0.0 +	33,1	+100.0	+100.0	+116.0 +	97.9	+165
+ 4	PROTE.0100000000000000	1100001000011000	0000	+ 0.0	- 0.0	+ 33.3	+ 33.4	+ 0.0	+ 0.0 +	33.4	+100.0	+100.0	+116.0 +	97.9	+165
+ 5	PROTE.0100000000000000	1100001000011000	0000	+ 0.0	- 0.2	+ 33.2	+ 33.1	+ 0.0	+ 0,0 +	33.1	+100.0	+100.0	+116.0 +	97.8	+165
+ 6	PROTE.0100000000000000	1100001000011000	0000	+ 0.0	- 0.0	+ 3.2	+ 33.1	+ 0.0	+ 0.0 +	33.1	+100.0	+100.0	+115.9 +	97.9	+165
+ 7	PROTE.0100000000000000	100001000011000	0000	+ 0.0	- 0.0	+ 33.2	+ 33.1	+ 0.0	+ 0,0 +	33.1	+100.0	+100.0	+115.9 +	97.4	+165
+ 8	PROTE.0100000000000000	1100001000011000	0000	+ 0.0	- 0.2	+ 33.1	+ 32.9	+ 0.0	+ 0.0 +	32.9	+100.0	+100.0	+115.8 +	97.8	+165
+ 9	PROTE.0100000000000000	1100001000011000	0000	+ 0.0	- 0.0	+ 33.1	+ 32.9	+ 0.0	+ 0.0 +	32.9	+100.0	+100.0	+115.8 +	97.4	+165
+ 10	PROTE.0100000000000000	1100001000011000	0000	+ 0.0	- 0.0	+ 33.1	+ 32.9	+ 0.0	+ 0.0 +	32.9	+100.0	+100.0	+115.8 +	97.9	+165
+ 11	PROTE.0100000000000000	1100001000011000	0000	+ 0.0	- 0.0	+ 33.0	+ 32.6	+ 0.0	+ 0.0 +	32.6	+100.0	+100.0	+115.8 +	97.9	+165
+ 12	PROTE.0100000000000000	1100001000011000	0000	+ 0.0	- 0.0	+ 33.0	+ 32.6	+ 0.0	+ 0.0 +	32.6	+100.0	+100.0	+115.8 +	97.9	+165
+ 13	PROTE.0100000000000000	1100001000011000	0000	+ 0.0	- 0.0	+ 33.0	+ 32.6	+ 0.0	+ 0.0 +	32.6	+100.0	+100.0	+115.9 +	97.8	+165
+ 14	PROTE.0100000000000000	1100001000011000	0000	+ 0.0	-0.0	+ 32.9	+ 32.6	+ 0.0	+ 0.0 +	32.6	+100.0	+100.0	+115.9 +	98.2	+165
+ 15	PROTE.0100000000000000	1100001000011000	0000	+ 0.0	-0.0	+ 32.9	+ 32.4	+ 0.0	+ 0.0 +	32.4	+100.0	+100.0	+116.0 +	97.9	+165
+ 16	PROTE.0100000000000000	1100001000011000	0000	+ 0.0	-0.0	+ 32.9	+ 32.4	+ 0.0	+ 0.0 +	32.4	+100.0	+100.0	+116.0 +	98.2	+165
+ 17	PROTE.0100000000000000	1100001000011000	0000	+ 0.0	-0.0	+ 32.8	+ 32.4	+ 0.0	+ 0.0 +	32.1	+100.0	+100.0	+116.1 +	97.9	+165
+ 18	PROTE.0100000000000000	1100001000011000	0000	+ 0.0	-0.0	+ 32.8	+ 32.4	+ 0.0	+ 0.0 +	32.1	+100.0	+100.0	+116.1 +	98.2	+165
+ 19	PROTE.0100000000000000	1100001000011000	0000	+ 0.0	-0.2	+ 32.8	+ 32.1	+ 0.0	+ 0.0 +	32.1	+100.0	+100.0	+116.2 +	97.9	+165
+ 20	PROTE.0100000000000000	1100001000011000	0000	+ 0.0	-0.0	+ 32.7	+ 32.1	+ 0.0	+ 0.0 +	32.1	+100.0	+100.0	+116.2 +	98.2	+165
+ 21	PROTE.0100000000000000	1100001000011000	0000	+ 0.0	-0.0	+ 32.7	+ 32.1	+ 0.0	+ 0.0 +	31.8	+100.0	+100.0	+116.2 +	98.2	+165
+ 22	PROTE.0100000000000000	1100001000011000	0000	+ 0.0	-0.2	+ 32.7	+ 32.1	+ 0.0	+ 0.0 +	31.8	+100.0	+100.0	+116.2 +	98.2	+165
+ 23	PROTE.0100000000000000	1100001000011000	0000	+ 0.0	-0.0	+ 32.6	+ 31.8	+ 0.0	+ 0.0 +	31.6	+100.0	+100.0	+116.2 +	98.2	+165
+ 24	PROTE.0100000000000000	1100001000011000	0000	+ 0.0	-0.0	+ 32.6	+ 31.8	+ 0.0	+ 0.0 +	31.6	+100.0	+100.0	+116.3 +	98.2	+165
+ 25	PROTE.0100000000000000	1100001000011000	0000	+ 0.0	-0.0	+ 32.6	+ 31.6	+ 0.0	+ 0.0 +	31.6	+100.0	+100.0	+116.3 +	98.2	+165

NO ERRORS TRACING CAUSE = PRDTECTION Ext-P RECORDING TIME = 10ms

AUX1=AuxDgn AUX2= Eanl AUX3= Ean2

PROTECTIONS LEGENDA			LOGIC I/O LEGENDA		
X----------	0)	MainF	X----------	0)	Start
-X---------	1)	Ext_P	-X---------	1)	Ramp
--X--------	2)	IOC	--X--------	2)	IntRfl
---X-------	3)	W_Dog	---X-------	3)	IntRf2
----X------	4)	Ud_F	----X------	4)	Coml
-----X-----	5)	If_F	-----X-----	5)	COm2
------X----	6)	TachF	------X----	6)	Com3
-------X---	7)	Fan_F	-------X---	7)	COm4
--------X--	8)	Motoh	--------X--	8)	Com5
---------X-	9)	ConOh	---------X-	9)	Com6
----------X	10)	Ser_F	----------X	10)	Com7
----------X	11)	N_Max	----------X	11)	Kl
----------X	12)	UvOut	----------X	12)	K2
----------X	13)	Stale	----------X	13)	Outl
----------X	14)	Leg_F	----------X	14)	Out2
----------X	15)	-----	----------X	15)	Alarm

AUX"n"=AuxDgn LEGENDA			ALARMS LEGENDA		
X----------	0)	Out 3	X----------	0)	TachF
-X---------	1)	Out 4	-X---------	1)	Fan_F
--X--------	2)	Out 5	--X--------	2)	MotOh
---X-------	3)	Out 6	---X-------	3)	ConOh
			----X------	4)	-----
			-----X-----	5)	-----
			------X----	6)	-----
			-------X---	7)	Stale

THYRISTOR TRACE

N	Iao		Ia		ALFA	TS
-	8	+ 2	+	2	100	4F
-	7	+ 2	+	2	100	3F
-	6	+ 2	+	2	101	2F
-	5	+ 2	+	2	101	1F
-	4	+ 2	+	2	100	6F
-	3	+ 2	+	2	101	5F
-	2	+ 2	+	2	101	4F
-	1	+ 2	+	2	100	3F
	0	+ 0	+	0	165	2P
+	1	+ 0	+	0	165	1P
+	2	+ 0	+	0	165	6P
+	3	+ 0	+	0	165	SP
+	4	+ 0	+	0	165	4P
+	5	+ 0	+	0	165	3P
+	6	+ 0	+	0	165	2P
+	7	+ 0	+	0	165	1P

NO ERRORS TRACING CAUSE = PROTECTION Ext-P

APPENDIX C

• CONFIGURATION PARAMETERS

- A-CURRENT REG.

CA1	IaoSl	N_Reg	CA2	IaoLm	Fixed	CA3	IaoAd	Off	CA4	IaoWo	0
CA5	RateL	+ 100.0	CA6	IALNM	+ 100.0	CA7	NMDel	0	CA8	InThr	+ 2.0
CA9	IaLim	+ 100.0									

- B-SPEED REG.

CBA	Enable	On	CBB	Enc_f	Off	CBC	Int=0	Off	CBD	Rmp-B	On
CBE	MpoMem	Off	CBF	MpoRes	Off	CBG	TacFUd	Off	CBH	Wo_Ref	Off
CB1	NoSel	MpotFw	CB2	NoAdd	Off	CB3	N_Se	Encod	CB4	Mtime	10.0
CBS	Nstop	+ 2.0	CB6	Nhist	+ 0.3	CB7	ErNLm	+ 1.0	CB8	Enc_R	+ 100.0
CB9	M_Ref	+ 0.0									

- C-E.M.F. REG.

CCA	Enable	On	CCB	Flt_In	Off	CCC	FldO_P	On	CC1	Fecon	+ 100.0
CC2	FIDel	10	CC3	FecTm	1000	CC4	LXnn	+ 100.0			

- D-MISCELLANEA

CDA	W_Eepr	On	CDB	QuickS	Off	CDC	Diesel	Off	CDD	EncAbs	Off
CDE	IR12Ds	Off	CDF	Defau	Off	CD1	CD5	Nz_D 10	CD6	N_MxV	+ 100.0
CD7	N_Flt	0	CD8	NST_G	32	CD9	IIThr	+ 5.0			

- E-AUX. FUNCT. 1

CFA	Helpr	Off	CEB	Pope	Off	CEC	Step	Off	CED	Mloss	Off
CEE	Kramer	Off	CE1	NoRic	+ 10.0	CE2	S_Thr	+ 10.0	CE3	LossK	+ 10.0
CE	LK_N	+ 10.0	CES	IaThr	+ 10.0	CE6	N_Thr	+ 10.0	CE7	K_Gn	0
CE8	NLRic	+ 100.0	CE9	Ir_TN	+ 100.0						

- F-AUX. FUNCT. 2

CFA	G_Ric	Off	CFB	T_Prf	Off	CFC	L_W	Off	CFD	FTR	Off
CFE	Flux_R	Off	CFF	FUd_C3	Off	CF1	TPLim	+ 10.0	CF2	TP_T	100
CF3	LW_Fr	+ 10.0	CF4	RmpTm	10.0	CF5	Tf(D)	0	CF6	LW_Tm	50
CF7	ERNAR	+ 10.0	CF8	ErN_T	10						

- G-POSITION REG.

CGA	Enable	Off	CGB	PosSp	Off	CGC	PosFbk	Off	CG1	K_POS	0
CG2	Acc_S	+ 2.0	CG3	PrefF	0	CG4	PrefB	0	CGS	P_Err	100

- H-P.L.C.

CHA	Enable	Off	CEB	Fld_C	Off	CHC	H_OpC	Off	CHD	PwC_CS	Off
CHE	F1C_CS	Off	CHl	ContD	5.0						

- CONFIGURATION PARAMETERS

- J-TENSION REG.

CJA	T_En	Off	CJB	W_En	Off	CJC	Taper	Off	CJ1	ToSel	P_CJ4
CJ2	T_Sel	Serial	CJ3	ToNOS	ToN0Of	CJ4	ToRef	+ 0.0	CJS	ToN=O	+ 0.0
CJ6	TapTy	Lin.	CJ7	TapDo	+ 10.0	CJ8	Tap_V	+ 50.0	CJ9	TtoNO	10.0

- K-LOAD CELL REG.

CKA	LC_F	Off	CKB	TErr=0	Off	CKC	Gi_Fix	Off	CK1	T_K	100
CK2	Appl.	Nloop	CK3	K_Int	+ 20.0						

- L-WINDER REG.

CL1	Type	Axial	CL2	W_Flt	20	CL3	W_Sel	Wind	CL4	Mat_P	Normal
CL5	ToRic	+ 100.0									

- N-INERTIA COMP.

CMA	Enable	Off	CMl	Type	Const.	CM2	DensS	P_CM4	CM3	WdthS	P_CM5
CM4	Dens.	+ 100.0	C95	Width	+ 100.0	CM6	AccTo	0.0	CM7	AccTl	100.0
CM8	AccT2	100.0									

- N-DIAMETER CALC.

CN1	D_Min	+ 10.0	CN2	FdimS	P_CN3	CN3	Fdiam	+ 10.0	CN4	CDThr	+ 2.0
CN5	Wtime	600	CN6	DiamS	Off						

- 0-BACKLASH COMP.

COA	Enable	Off	C01	B_Val	+ 1.0	C02	Btime	10	C03	B_Rmp	10

- TUNING PAPAMETERS

- A-CURRENT REG.

TA1	G_Pl		32	TA2	G_dl		56	TA3	IaTL	+	100.0	TA4	IABL1	- 100.0
TA5	IaOfl	+	0.0											

- B-ALT. CURRENT

TB1	G_P2		32	TB2	G_d2		56	TB3	IaTL	+	100.0	TB4	IaBL2	- 100.0
TB5	IaOf2	+	0.0											

- C-SPEED REG.

TC1	N_Gpl		400	TC2	N_Gil		50	TC3	N_Gd		0	TC4	NoLAl	+ 100.0
TC5	NoLI1	-	100.0	TC6	NoOfl	+	0.0	TC7	InR11	+	30.0	TC8	InR21	- 30,0
TC9	Ced	+	0.0											

- D-ALT. SPEED

TD1	N_GP2		400	TD2	N_Gi2		80	TD3	N_Gd2		0	TD4	NoLA2	+ 100.0
TD5	NoLI2	-	100.0	TD6	NoOf2	+	0.0	TD7	InRl2	+	30.0	TD8	InR22	- 30.0
TD9	Ced2	+	0.0											

- E-RAMP

TE1	TacRl		10.0	TE2	TdcR		10,0	TE3	TarRm		0.0

- F-ALT. RAMP

TF1	TacR2		10.0	TF2	TdcR2		10.0		

- G-E.M.F. REG.

TG1	E_Gp		100	TG2	E_Gi		16		

- E-GAINS ADAK .

TH1	GP_K1		0	TH2	Gi_Kl		0	TH3	Gd_Kl		0	TH4	Gp_K2	0
TH5	Gi_K2		0	TH6	Gd_K2		0	TH7	TcFGp		0	TH8	TcFGi	0

- J-POSITION REG.

TJ1	GpPos		0	TJ2	Gp_Pl		400	TJ3	Gi_Pl		80	TJ4	Gd_Pl	0
TJ5	Gp_P2		400	TJ6	Gi_P2		80	TJ7	Gd_P2		0			

- K-LOAD CELL REG.

TK1	Gp_T		100	TK2	Gi_T		100	TK3	TlimT	+	2.0	TK4	TlimB	- 2.0
TK5	NoLmT	+	100.0	TK6	NoLiB	-	100.0	TK7	Gd_T		0			

- DRIVE PAPAMETERS

- A-DRIVE IDENTIF.

DA1	Snumb	1	DA2	Bridg	Unid	DA3	Thyr	30			

- B-DRIVE I/O

DB1	UvoFs	380	DB2	If_Fs	3.0	DB3	Ia_Fs	30	DB4	Ud_Fs	400
DB5	N_Fs	2000	DB6	IaNom	+	100.0	DB7	Nbase	+	100.0	DB8	Enc_P	500
DB9	RI%	+ 0.0											

- C-PROTECTIONS

DCA	MainF	On	DCB	Ext_P	On	DCC	IOC	On	DCD	W_Dog	On
DCE	Ud_F	On	DCF	If_F	On	DCG	TachF	On	DCH	Fan_F	On
DCI	MotOh	On	DCJ	ConOh	On	DCK	Ser_F	On	DCL	N_Max	On
DCM	UvOut	On	DCN	Stale	On	DCO	Leg_F	On	DC1	UvoMn	+	80.0
DC2	UvoMx	+ 115.0	DC3	Fld_L	+	10.0	DC4	N_Max	+	115.0	DC5	UdMax	+	120.0
DC6	Tstal	5.0	DC7	Sncic	10	DCB	MOH_R	+	100.0	DC9	Fld_T	+	20.0

- D-ALARMS

DDA	TachF	Off	DDB	Fan_F	Off	DDC	MotOh	Off	DDD	ConOh	Off
DDE	Ser_F	Off	DDF	Stale	Off	DD1	ResA	0			

- E-SERIAL LINK

DEA	Enable	On	DEB	S_Com	Off	DEC	S_PC	On	DED	S_Par	On
DEE	S_Cum	Off	DEF	S_ComD	Off	DEG	S_D2	Off	DEE	S_PLC	Off
DE1	BaudR	19.2K	DE2	IdNum	1	DE3	Ser_D	0			

- F-SERIAL DATA

DFA	Dl_n	Off	DFB	Dl_Sts	Off	DFC	DlLPro	Off	DFD	DlHPro	Off
DFE	D1Labi	Off	DFF	D1Habi	Off	DFG	D1Laul	Off	DFH	D1Haul	Off
DFI	D1LAu2	Off	DFJ	D1HAu2	Off	DFK	D1LAu3	Off	DFL	D1HAu3	Off
DFH	DlLNo	Off	DFN	DlHNo	Off	DFO	D1L_N	Off	DFP	D1H_N	Off
Dfa	D1Liao	Off	DFb	D1Riao	Off	DFc	D1L_Ia	Off	DFd	D1H_Ia	Off
Dfe	DlL_Ud	Off	DFf	D1H_Ud	Off	DFg	DlLFlu	Off	DFh	D1Hflu	Off
Dfi	D1Lifo	Off	DFj	D1Hifo	Off	DFk	D1L_If	Off	DFl	D1H_If	Off
DFm	D1Luvo	Off	DFn	DlffUvo	Off	Dfo	D1L_a	Off	DFp	DlH_a	Off

- G-DIAGNOSTICS

DGA	Tstop	Off	DGB	Sstop	Off	DGC	Inst_M	Off	DG1	TrcNr	25
DG2	TrcNc	1	DG3	Th_Nr	7	DG4	StatV	N	DGS	Aux1S	AuxDgn
DG6	Aux2S	Eanl	DG7	Aux3S	Ean2	DG8	D_Ref	+	10.0	DG9	TimeP	1.0

- DRIVE PARAMETERS

- H-ANALOG INP.OFS

DFA	Dl_n		Off	DFB	Dl_Sts		Off	DFC	DlLPro		Off	DFD	DlHPro		Off
DH1	TacOf	+	0.0	DH2	IfOfs	+	0.0	DH3	ElOfs	+	0.0	DH4	E2Ofs	+	0.0
DH5	Udofs	+	0.0	DH6	RifOf	+	0.0								

- J-ANALOG INP.GN.

DJl	TachG	+	100.0	DJ2	If_G	+	100.0	DJ3	EanlG	+	100.0	DJ4	Ean2G	+	100.0
DJ5	Ud_G	+	100.0	DJ6	Rif_G	+	100.0	DJ7	Uvo_G	+	100.0	DJ8	Ia_G	+	100.0

- K-ANALOG INP.FLT

DK1	TacFl		0	DK2	If_Fl		20	DK3	EanlF		0	DK4	Ean2F		0
DK5	Ud_Fl		0	DK6	RifFl		0								

- L-ANALOG INP.ABS

DLA	TacAb		Off	DLB	IfAbs		Off	DLC	ElAbs		Off	DLD	E2Abs		Off
DLE	RifAbs		Off												

- M-ANALOG OUTPUTS

DMA	PwlAb		Off	DMB	Pw2Ab		Off	DMC	Pw3Ab		Off	DM1	Pw1S1		Ud
DM2	Pw2S1		Ifo	DM3	Pw3S1		N	DM4	Pw10f	+	0.0	DM5	Pw20f	+	0.0
DM6	Pw30f	+	0.0	DM7	Pwl_G	+	100.0	DM8	Pw2_G	-	100.0	DM9	Pw3_G	+	100.0

- N-DIGITAL INPUTS

DNA	ComlL		Off	DNB	Com2L		Off	DNC	Com3L		Off	DND	Com4L		Off
DNE	Com5L		Off	DNF	Com6L		Off	DNG	Com7L		Off	DN1	ComlS		Off
DN2	Com2S		Off	DN3	Com3S		Off	DN4	Com4S		Off	DN5	Com5S		Off
DN6	Com6S		Off	DN7	Com7S		Off								

- 0-DIGITAL OUTPUT

DOA	OutlL		Off	DOB	Out2L		Off	DOC	Out3L		Off	DOD	Out4L		Off
DOE	OutSL		Off	DOF	Out6L		Off	D01	Out1s		Alarm	D02	Out2S		Ia_Lim
D03	Out3S		Bridge	D04	Out4S		Enable	DO5	Out5S		ErrN=O	D06	Out6S		UdFail

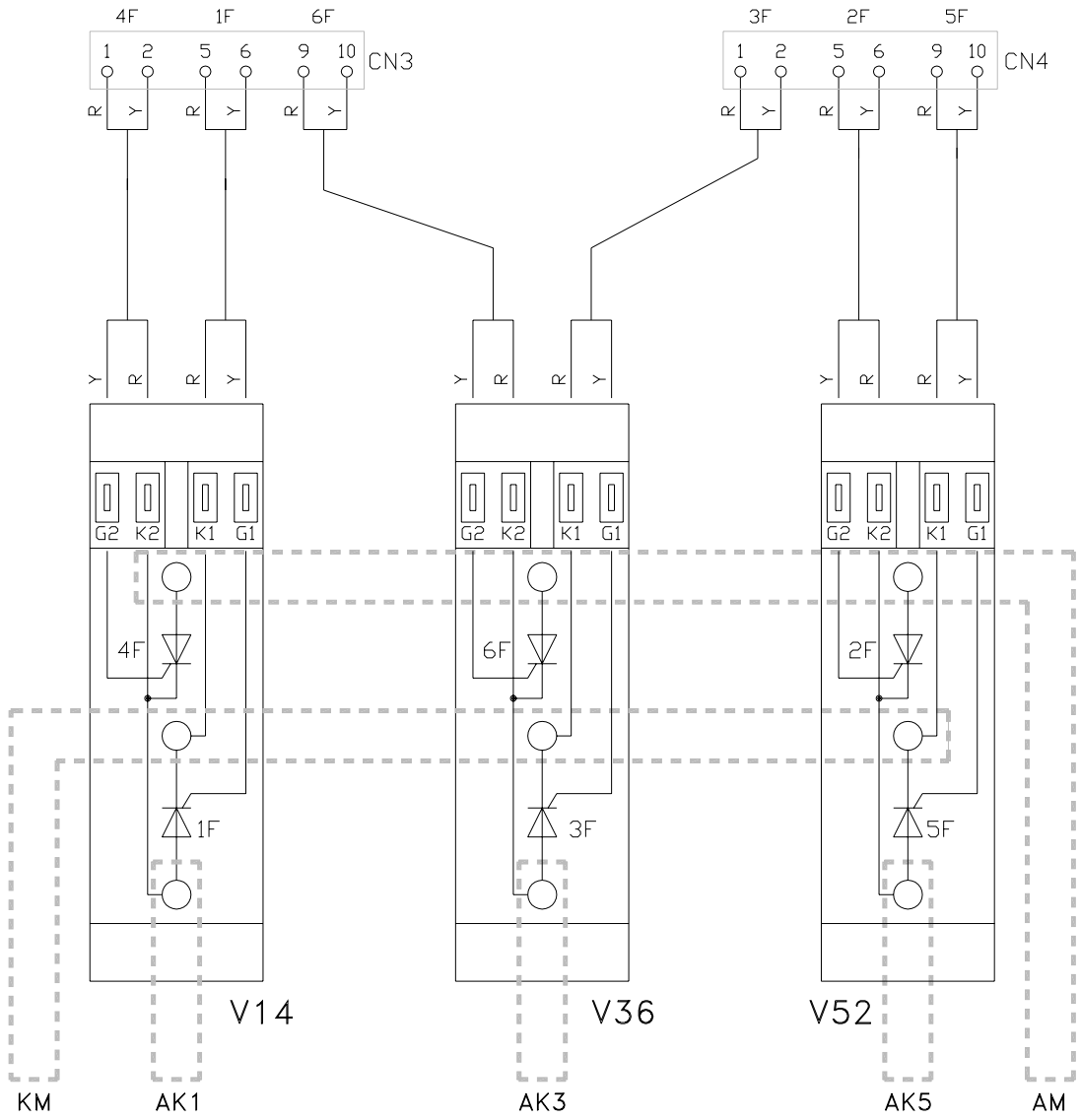
- P-MAGNET. CHAR.

DP1	M_Kl	+	4.9	DP2	M_K2	+	9.8	DP3	M_K3	+	14.6	DP4	M_K4	+	24.4
DP5	M_K5	+	40.0	DP6	M_K6	+	70.0								

APPENDIX D Bridges Layout

Nota: Codes G1, G2, K1, K2 shown in the diagram for the gate and catode connections may not be the same on the thyristors (depending on the manufacturer). Verify the label on the side of the thyristor.

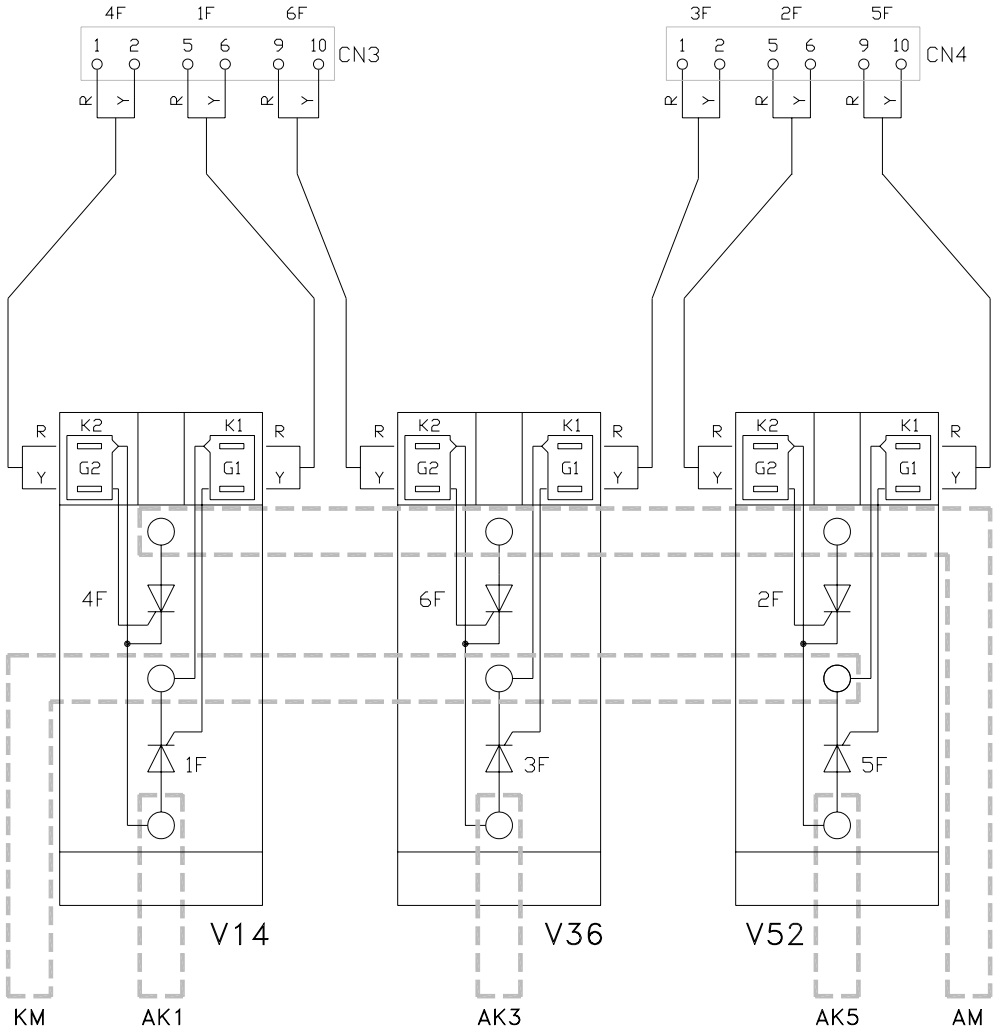
R = RED
Y = YELLOW



PONTE UNIDIREZIONALE- 2 QUADRANT BRIDGE

TAGLIA-SIZE (A)	30	60	80	110	160	200
TIRISTORE-THYRISTOR (A)	26	70	70	90	90	105

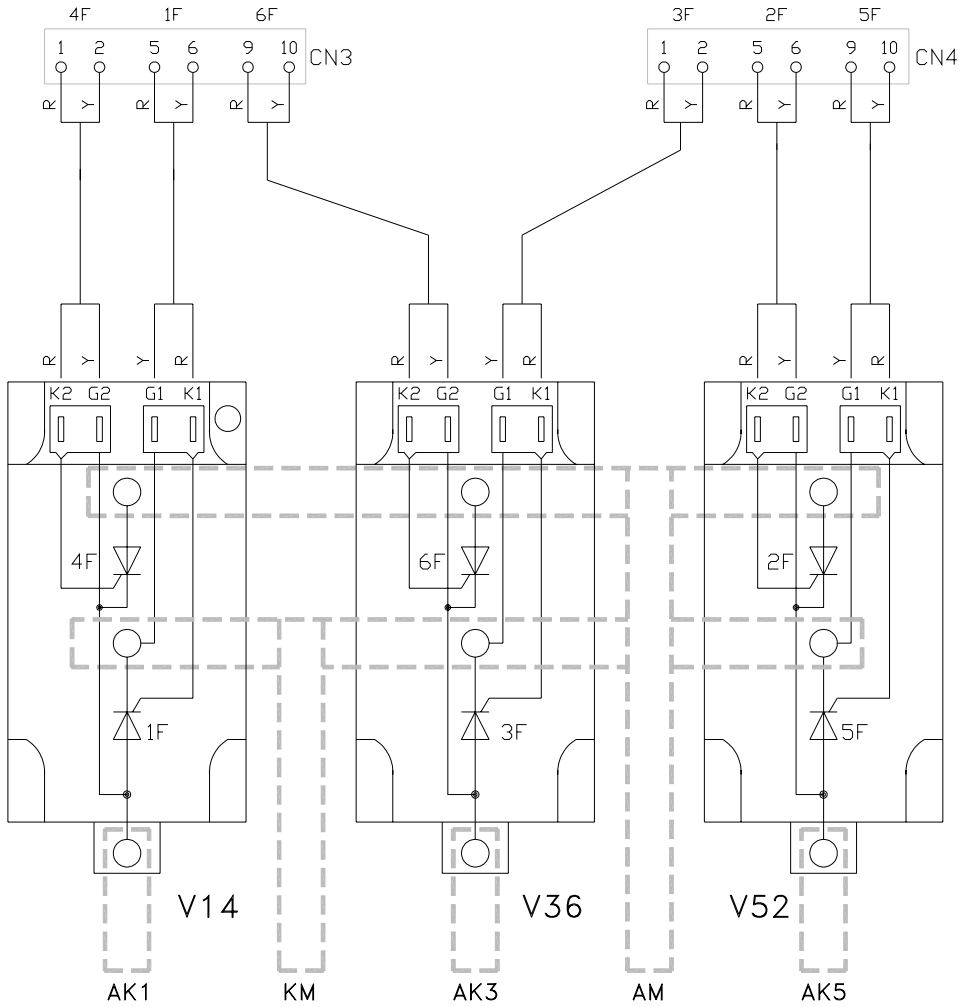
R = RED
Y = YELLOW



PONTE UNIDIREZIONALE-2 QUADRANT BRIDGE

TAGLIA -SIZE (A)	260	350	450
TIRISTORE - THYRISTOR (A)	130	180	180

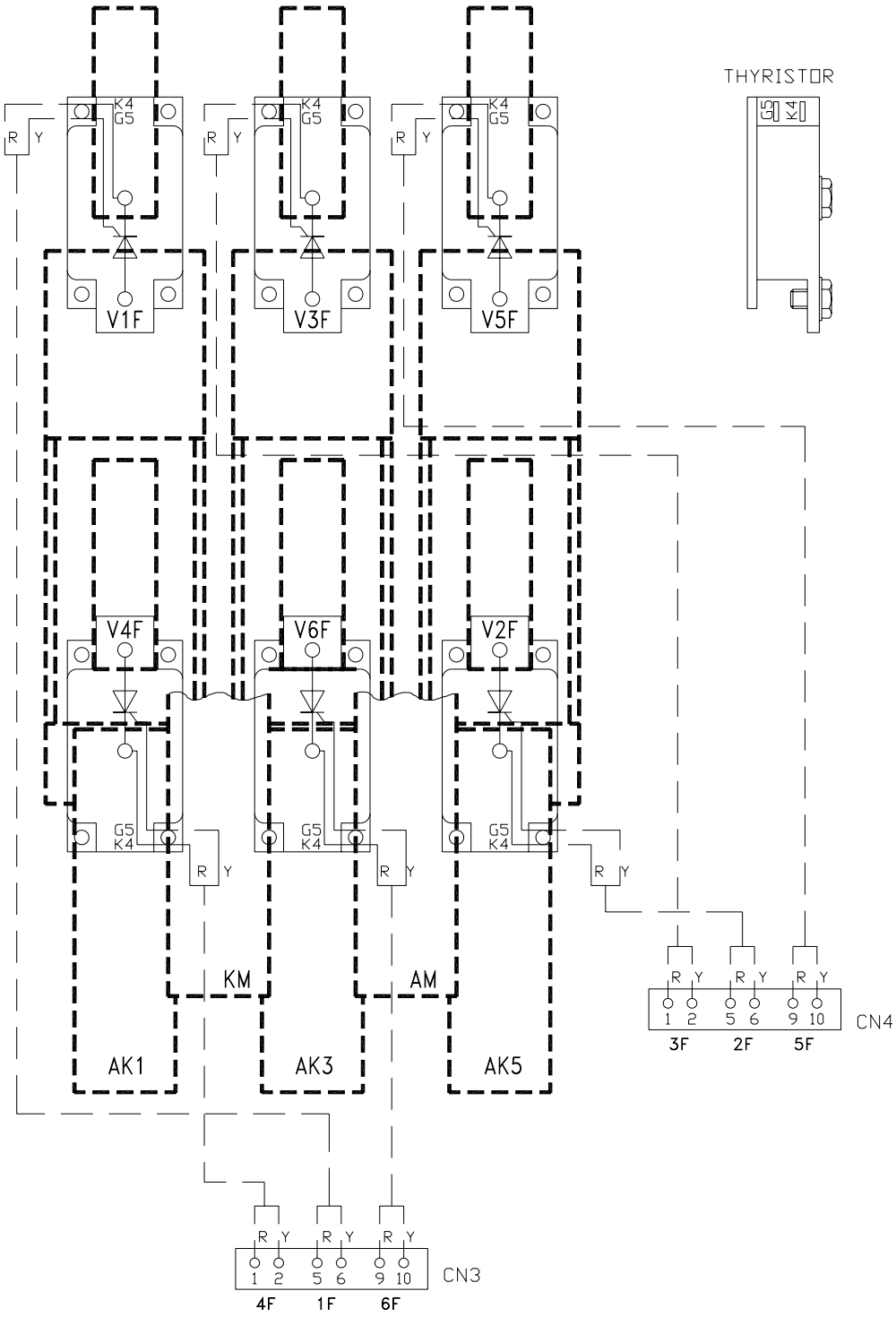
R = RED
Y = YELLOW



PONTE UNIDIREZIONALE - 2 QUADRANT BRIDGE

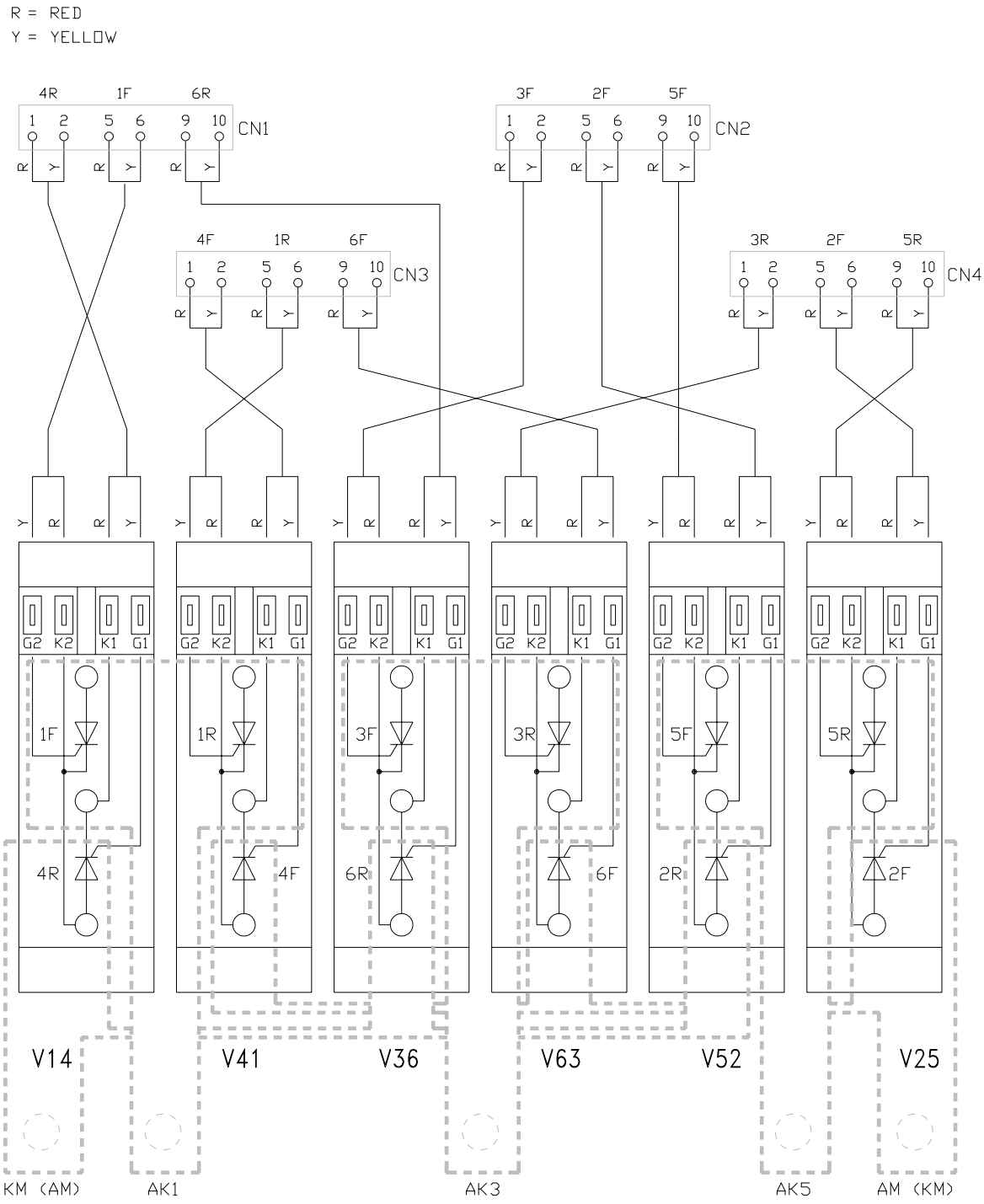
TAGLIA - SIZE (A)	500	600
TIRISTORE - THYRISTOR (A)	210	250

R = RED
Y = YELLOW



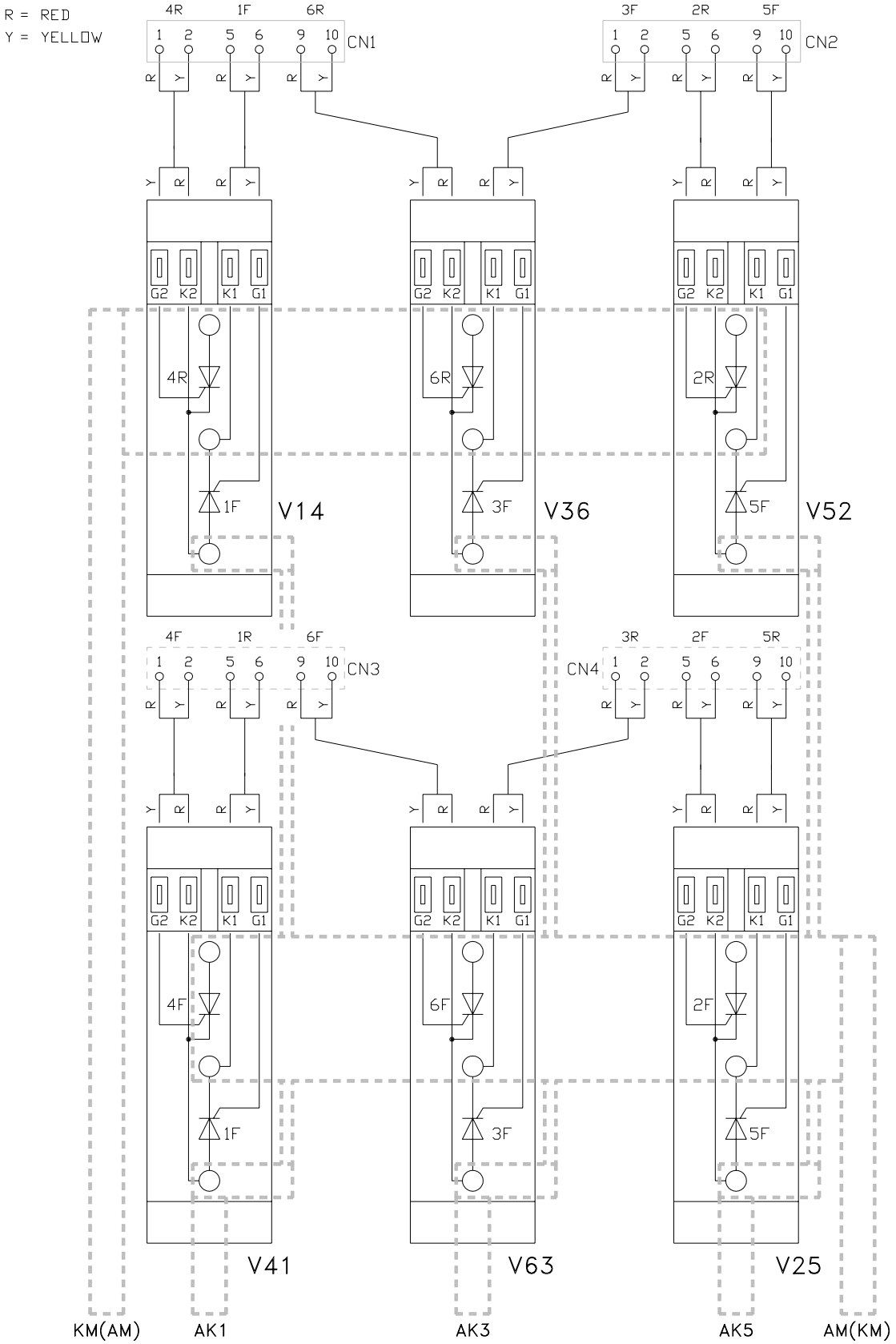
PONTE UNIDIREZIONALE - 2 QUADRANT BRIDGE

TAGLIA - SIZE (A)	850	1100
TIRISTORE - THYRISTOR (A)	330	400



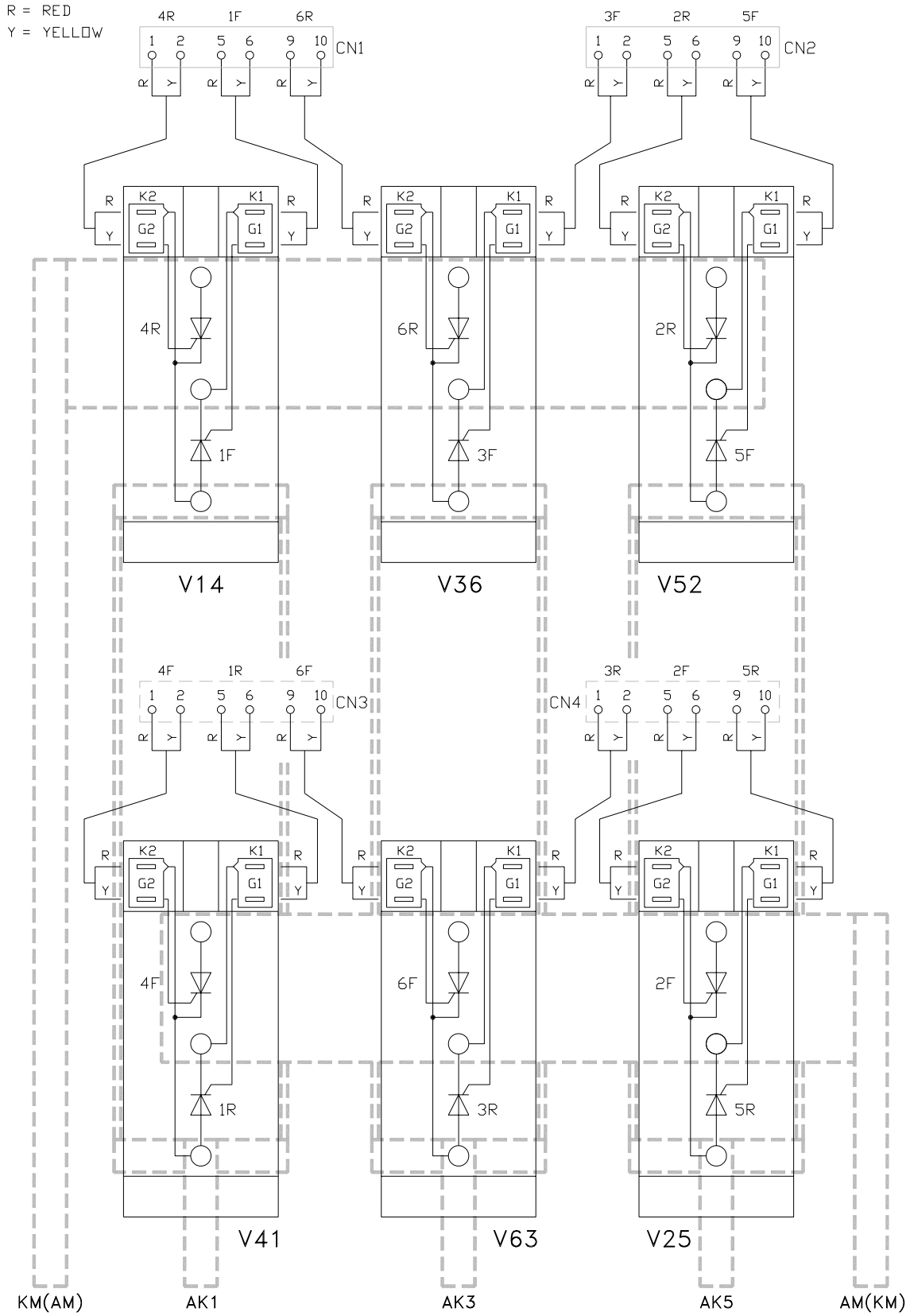
PONTE REVERSIBILE – 4 QUADRANT BRIDGE

TAGLIA - SIZE (A)	30	60	80	110
TIRISTORE - THYRISTOR (A)	26	70	70	90



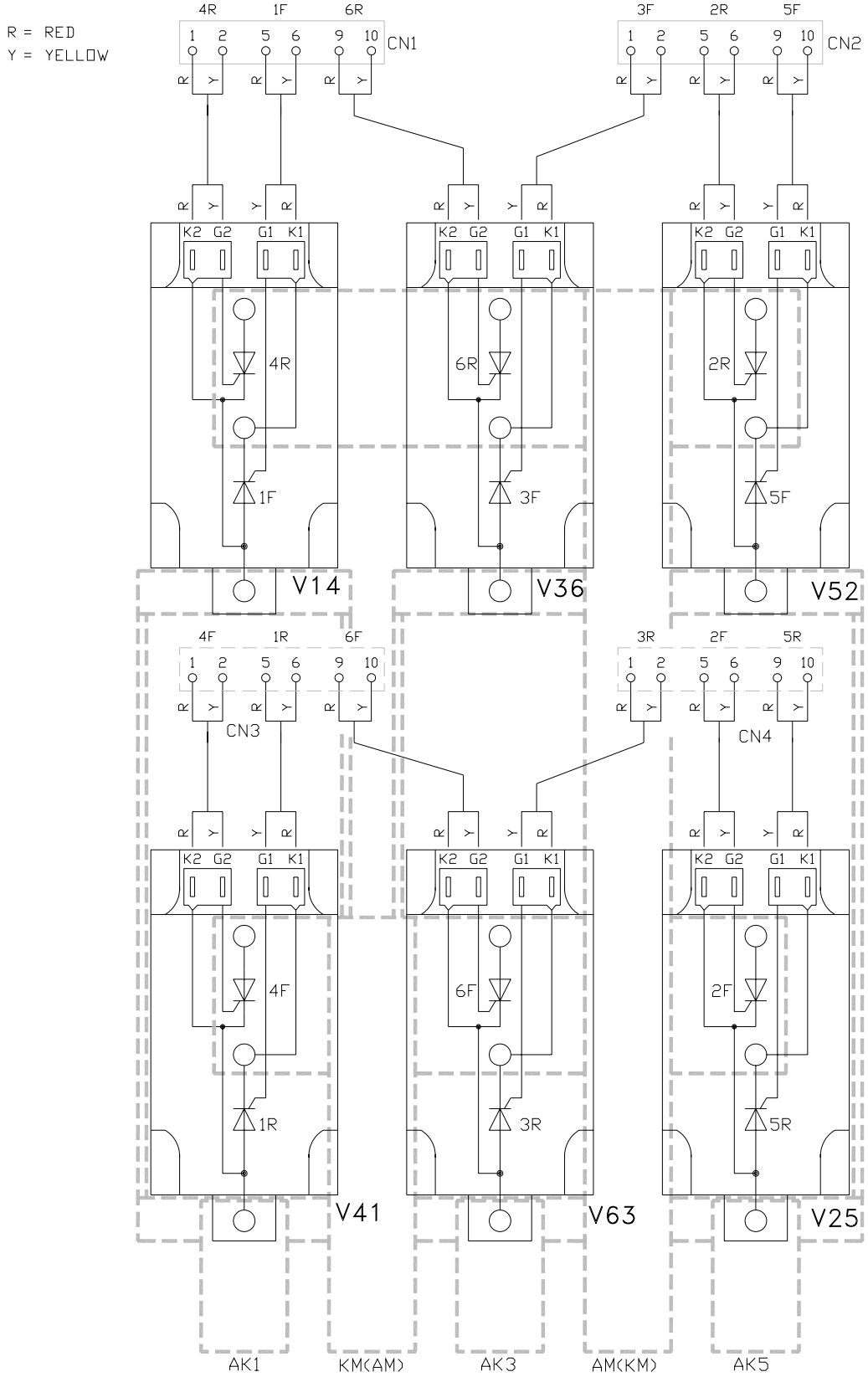
PONTE REVERSIBILE - 4 QUADRANT BRIDGE

TAGLIA - SIZE (A)	160	200
TIRISTORE - THYRISTOR (A)	90	105



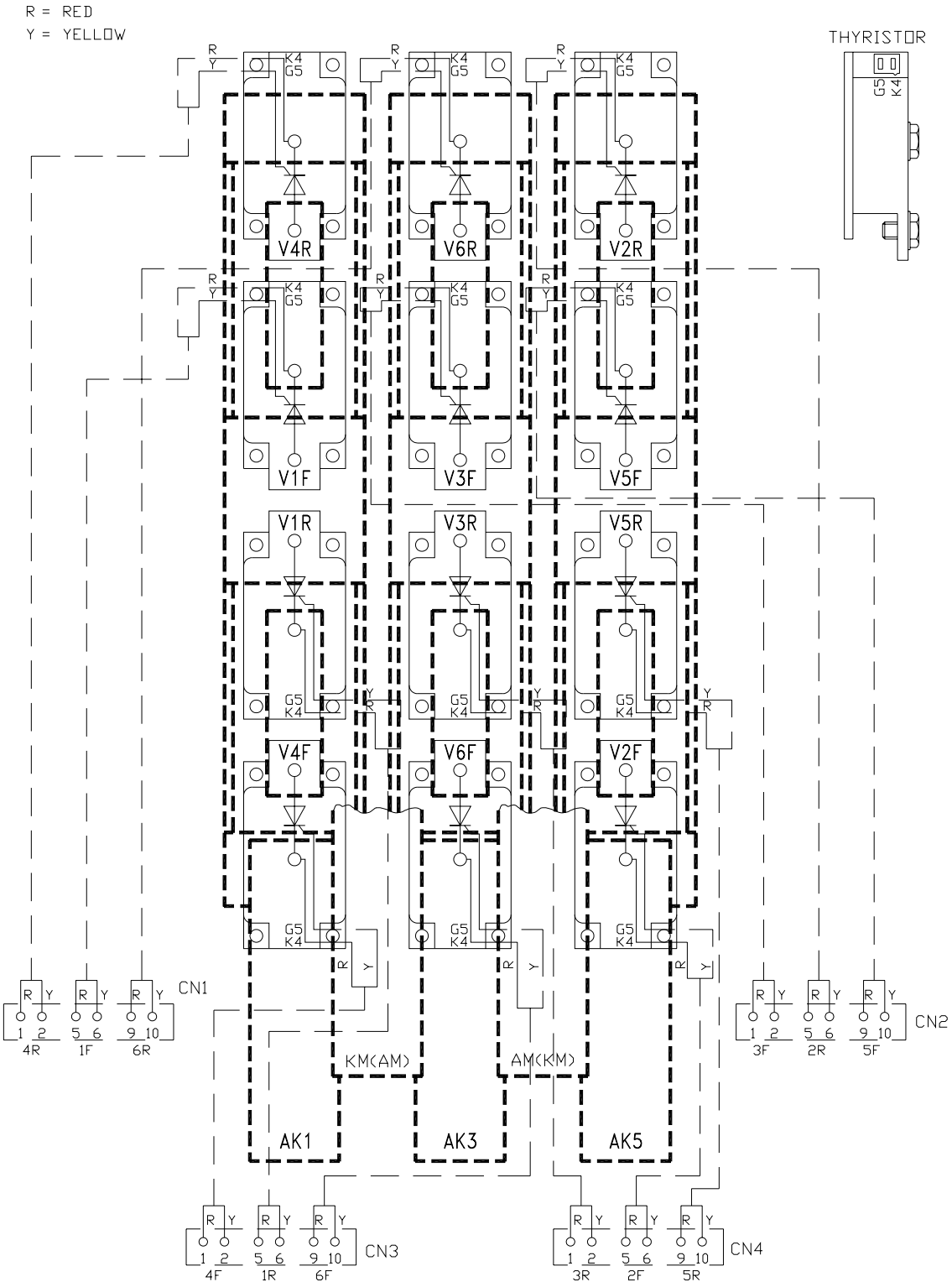
PONTE REVERSIBILE - 4 QUADRANT BRIDGE

TAGLIA - SIZE (A)	260	350	450
TIRISTORE - THYRISTOR (A)	130	180	180



PONTE REVERSIBILE - 4 QUADRANT BRIDGE

TAGLIA - SIZE (A)	500	600
TIRISTORE - THYRISTOR (A)	210	250



PONTE REVERSIBILE - 4 QUADRANT BRIDGE

TAGLIA - SIZE (A)	750	850	1100
TIRISTORE - THYRISTOR (A)	330	330	400

APPENDIX E EMC INSTRUCTIONS

E.1 EN61800-3 EMC product standard for adjustable speed electrical power drive systems

EN 61800-3:2004 Adjustable speed electrical drive systems. Part 3: EMC product standard including specific test methods. The transition period for the existing EN 61800-3:1996 expires on 1st October 2007.
The EN 61800-3 includes the electrical power drive system from the mains connection to the shaft of the motor, defines different categories C1 to C4, different environments (residential areas/industrial areas), external ports and internal interfaces.
It defines assessment criteria for the operational performance in case of interference at the external ports and the internal interfaces according to the environment at the installation site.

E.1.1 INSTALLATION ENVIRONMENT (Definitions)

First environment (residential and commercial areas):
Environment that includes domestic premises. It also includes establishments directly connected without intermediate transformers to a low-voltage power supply network which supplies buildings used for domestic purposes.

Second environment (industrial area):
Environment that includes all establishments other than those directly connected to a low-voltage power supply network which supplies buildings used for domestic purposes.

NOTE "For PDS's in the second environment, the user shall ensure that excessive disturbances are not induced into low-voltage network, even if propagation is through a medium voltage network."

Private network
The private network is characterised by being supplied by a dedicated medium voltage network and not supplying residential areas. Typically, the private main supplies commercial premises, offices in a residential building, shopping centres, etc. The operator can decide whether he realises the network according to the first or second environment as defined by the standard.
A private low-voltage network can be regarded as a plant in compliance with the EMC law. The EMC is assessed according to the physical limits of the plant, emission and immunity to radiated RF-fields are assessed according to the space limits and
conducted phenomena are assessed according to the input to the supplying network

E.1.2 EN 61 800-3 Categories

Category C1: Drive systems for rated voltages less than 1000 V for unlimited use in the first environment.

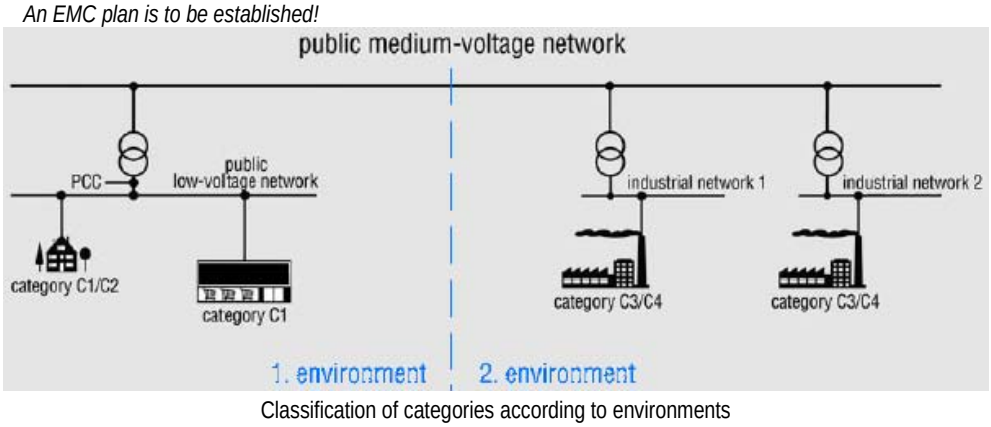
Category C2: Stationary drive systems for rated voltages less than 1000 V for use in the second environment. It is possible the use in the first environment which fulfil all the following criteria:
- Rated voltage < 1000 V
- no plug-in device
- no movable device
- Installation and commissioning only by a professional (a person/organisation having necessary skills in installing and/or commissioning power drive systems, including their EMC aspects)
- Warning required.

Warning in the instructions for use:
"This is a product of category C2 according to IEC 61800-3. In a domestic environment this product may cause radio interference in which case supplementary mitigation measures may be required."

Category C3: Drive systems with rated voltage < 1000 V, intended for use in the second environment and not intended for use in the first environment.
Warning in the instructions for use:
"This type of PDS is not intended to be used on a low-voltage public network which supplies domestic premises. Radio frequency interference is expected if used on such a network".

Category C4: for use in the second environment, which fulfil at least one of the following criteria:
- Rated voltage ≥1000 V
- Rated current ≥400 A
- connected to IT networks
- required dynamic performances will be limited as a result of filtering

An EMC plan is to be established!



Classification of categories according to environments

Solutions to fulfil conducted emission requirements

The emissions can be divided into two parts, the conducted emission and the radiated emission.
The disturbances can be emitted in various ways. Conducted disturbances can propagate to other equipment via all conductive parts including cabling, earthing and the metal frame of an enclosure.

Conducted emission: Can be reduced in the following way:

By RFI filtering for HF disturbances

Using sparking suppressors in relays, contactors, valves, etc. to attenuate switching sparks

Using ferrite rings in power connection points

Radiated emission: To be able to avoid disturbance through air, all parts of the PDS should form a Faraday Cage against radiated emissions. The PDS includes cabinets, auxiliary boxes, cabling, motors, etc. Some methods for ensuring the continuity of the Faraday Cage are listed as follows:

Enclosure:

- The enclosure must have an unpainted non-corroding surface finish at every point that other plates, doors, etc. make contact.
- Unpainted metal to metal contacts shall be used throughout, with conductive gaskets, where appropriate.
- Use unpainted installation plates, bonded to common earth point, ensuring all separate metal items are firmly bonded to achieve a single path to earth
- Use conductive gaskets in doors and covers. Covers should be secured at not more than 100 mm intervals where radiation could escape.
- Separate radiative i.e. “dirty” side from the “clean side” by metal covers and design.
- Holes in enclosure should be minimised.
- Use materials with good attenuation e.g. plastic with conductive coating, if a metal enclosure cannot be used.

Cabling & Wiring:

- Use special HF cable entries for high frequency earthing of power cable shields.
- Use conductive gaskets for HF earthing of control cable shield.
- Use shielded power and control cables.
- Route power and control cables separately.
- Use twisted pairs to avoid common mode disturbances.
- Use ferrite rings for common mode disturbances, if necessary.
- Select and route internal wires correctly.

Installation:

- Auxiliaries used with CDM’s should be CE marked products to both EMC & Low Voltage Directives, not only to LV directive, unless they are not concerned, e.g. being with a component without a direct function.
- Selection and installation of accessories in accordance with manufacturers’ instructions
- 360° earthing at motor end.
- Correct internal wiring methods.
- Special attention must be given to earthing.

E1.4 RFI FILTER

The EMC emission limits for PDS depend on the installation environment, type of power supply network and power of the drive. Limits for certain conditions can be selected by using the flow chart on Figure 3A.4.

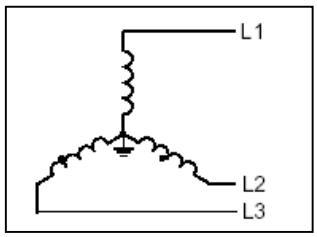
RFI filters are used to attenuate conducted disturbances in a line connecting point where the filter leads the disturbances to earth.
RFI filters are needed when a PDS is connected to the public low-voltage network (First Environment).
It is also recommended to use filters in industrial situations (Second Environment), if there are potential victims in the neighbourhood and thus possible EMC problems.

Installation of the RFI filter: Reliable HF/low impedance connections are essential to ensure proper functioning of the filter, therefore the following instructions shall be followed.

- Filter shall be assembled on a metal plate with unpainted connection points all in accordance with filter manufacturer’s instructions.
- The frames of the filter cubicle (if separate) and the drive cubicle shall be bolted together at several points. Paint shall be removed from all connection points.
- The input and output cables of the filter shall not run in parallel, and must be separated from each other.
- The maximum length of the cable between the filter and the drive must be shorter than 0.3m; do not obstruct the drive cooling intake. For longer connections use a shielded cable only..
- The filter must be earthed using the designated filter ground terminal only. Note that the cable type and size are critical.

Relays, contactors and magnetic valves must be equipped with spark suppressors. This is also necessary when these parts are mounted outside the frequency converter cubicle.

RFI filter in a earthed line (TN or TT)Network:



The filters are suitable for earthed lines only, for example in public European 400 V lines. According to EN 61800-3, filters are not compatible in insulated industrial lines with own supply transformers due to their safety risks in such floating lines (IT networks).

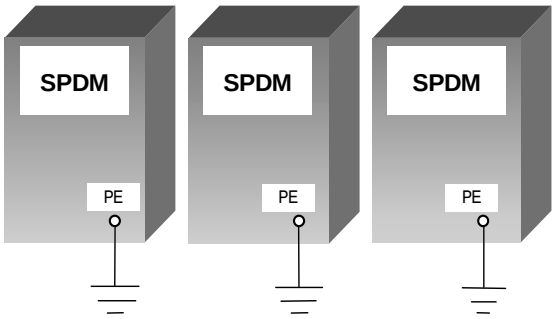
Earth fault detection:

Filters (with internal discharging resistors), cables, the converter and the motor have together a considerable capacitance to ground, which can cause an increased leakage earth current (>30mA).
The tripping threshold of an earth fault detector that measures this current must be adapted to this higher value.

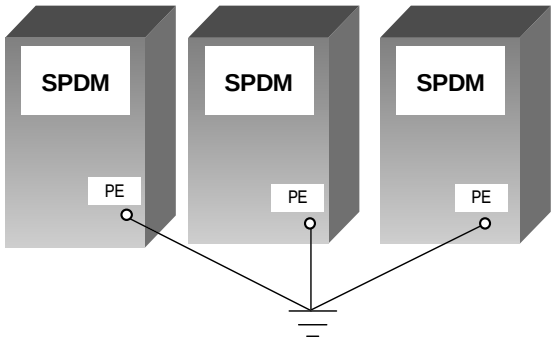
Ground Connections

For personnel safety, proper operation and to reduce electromagnetic emission/pickup, the drive and the motor must be grounded at the installation site. A star ground system is acceptable although it is not the preferred method.

- Conductors must be adequately sized as required by safety regulations.
- Power cable shields must be connected to the drive PE terminal in order to meet safety regulations.
- Power cable shields are suitable for use as equipment grounding conductors only when the shield conductors are adequately sized as required by safety regulations.
- In multiple drive installations, do not connect drive terminals in series.
- The panel must have a properly sized ground bus to which all system grounds are connected. The bus bar shall be connected to plant ground.
- Ground connections must be as short as possible.
- The drive ground connection should not be shared with other devices.
- High frequency RFI requires large areas of ground bus (due to skin effect).



a) Preferred connection



b) Accettable connection

Floating Networks IT (ungrounded) systems:

For floating networks (also known as IT, ungrounded, or impedance/resistance (greater than 30Ω) grounded networks), if the drive is equipped with EMC filter:

• Disconnect the filter before connecting the drive to an ungrounded system.

• Where EMC requirements exist, check for excessive emission propagated to neighboring low voltage networks. In some cases, the natural suppression in transformers and cables is sufficient. If in doubt, use a supply transformer with static screening between the primary and secondary windings.

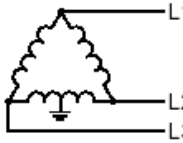
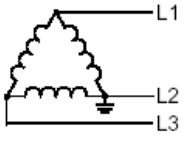
CAUTION!



The filter shall be grounded before applying power.
The filter can only be used with balanced supply mains.
Do not attempt to install or remove RFI filter connections while power is applied to the drive's input terminals
If a drive with EMC filter is installed on an IT system the system will be connected to earth potential through the EMC filter capacitors of the drive. This may cause danger or damage the unit.
The filter shall not be connected to the drive output (motor side).

Unsymmetrically Grounded Networks

Unsymmetrically grounded networks are defined in the following table. In such networks, the RFI filter internal connection must be disconnected. If the grounding configuration of the network is unknown, remove RFI filter internal connection.

Unsymmetrically Grounded Networks – RFI filter must be disconnected			
Ground at the mid point of a leg		Ground at the corner of the delta	

E1.5 SPDM COMPLIANCE WITH IEC 61800-3

CE MARK	A CE mark is attached on each drive in order to certificate the compliance of the SPDM converters to the provisions of the European Low Voltage and EMC Directives (Directive 73/23/EEC, and 89/336/EEC, and as amended by Directives 91/263/EEC, 92/31/EEC, 93/68/EEC and 93/97/EEC

The SPDM is almost exclusively used in the second enviroment (categories C3 and C4):
To limit the emitted interference, SPDM is equipped with EMC filter (installed outside the chassis) according the limits defined in Category C3. Optional EMC filters are available on request for use in the first ambient.

SPDM complies with noise immunity requirements defined in EN 61 800-3 for the second enviroment and thus also with the lower noise immunity requirements in the first enviroment.

The warning and installation information of this manual must be observed.

Note: a) The drive must not be equipped with the EMC filter when installed to IT (unearthed) systems. The mains becomes connected to earth potential through the EMC filter capacitors. In IT systems this may cause danger or damage the unit.

b) Refer to Figure E1.3/4 for filter connection to the drive.

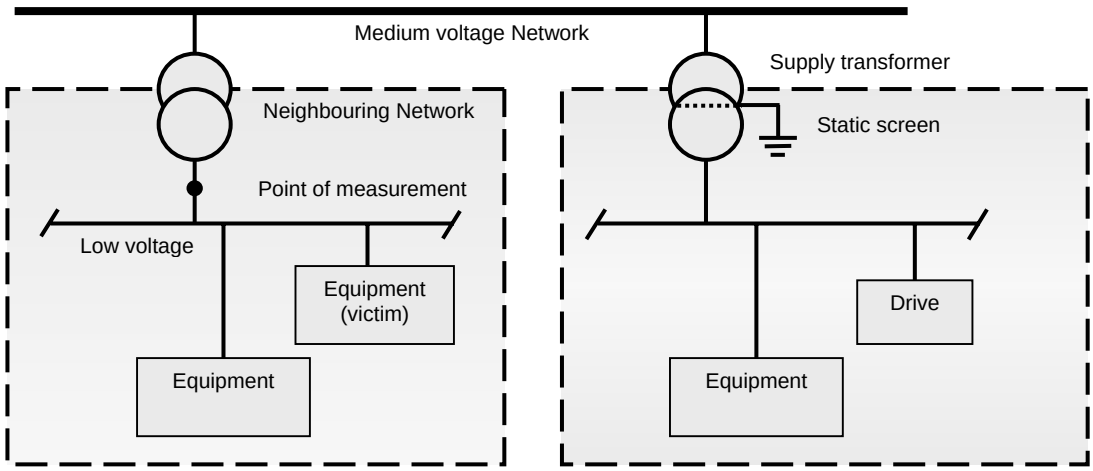
c) RFI filter codes are in Table E1.1 and E1.2

WARNING! The drive may cause radio interference if used in a residential or domestic environment. The user is required to take measures to prevent interference, in addition to the requirements for CE compliance listed above, if necessary.

Note:

If the above listed provisions cannot be met, e.g., the drive cannot be equipped with EMC filter when installed to an IT (unearthed) network, the requirements of the EMC Directive can be met as follows for restricted distribution:

1. It is ensured that no excessive emission is propagated to neighbouring low-voltage networks. In some cases, the natural suppression in transformers and cables is sufficient. If in doubt, a supply transformer with static screening between the primary and secondary windings can be used.



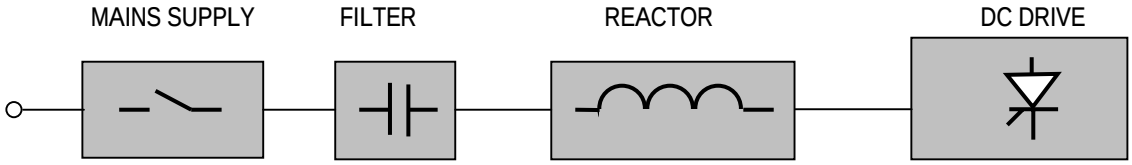
2. An EMC plan for preventing disturbances is drawn up for the installation.

3. The motor and control cables are selected as specified in the *Hardware Manual*.

4. The drive is installed according to the instructions given in the *Hardware Manual*.

EMC COMPLIANT INSTALLATION

EMI filters are series-wired on the supply line of the drive, therefore they have to be sized according to the load current of the device.
It is compulsory wiring the filter with the sequence in the following figure.



The choke should be connected between filter and drive. Wiring the filter in the wrong sequence can damage the converter.

In case a separation transformer is applied, its screen and iron core must be grounded in order utilise the filtering effect. If no static screen is present, an appropriate filter must be used.

Table E1.1

DRIVE		MOTOR	RFI FILTER (500V ±10% --50/60Hz ±4%)						
Type	Rated current	Rated current	SAP code	Rated current	Leakage current	Dimensions (mm)			Weigth
	◆ A	A		(IF) A	mA	L	A	P	Kg
SPDM030_F	30	18	ELC40969901	12	29	50	420	206	
SPDM030_F	30	30	ELC40969902	21	29	50	420	206	
SPDM060_F	60	60	ELC40969903	40	30	170	151	90	
SPDM080_F	80	76	ELC40732501	50	30	170	151	90	
SPDM080_F	80	80	ELC40732502	65	30	170	151	90	
SPDM110_F	110	110	ELC40732503	90	32	260	151	90	
SPDM160_F	160	160	ELC40732504	150	32	280	151	110	
SPDM200_F	200	200	ELC40732504	150	32	280	151	110	
SPDM260_F	260	229	ELC40732504	150	6	280	151	110	15
SPDM260_F	260	260	ELC40732505	180	6	390	190	115	15
SPDM350_F	350	350	ELC40821101	250	6	390	190	115	15
SPDM450_F	450	380	ELC40821101	250	6	390	190	115	15
SPDM450_F	450	450	ELC40821102	320	6	390	260	115	21
SPDM600_F	600	488	ELC40821102	320	6	390	260	115	21
SPDM600_F	600	600	ELC40821107	400	6	390	260	115	21
SPDM850_F	850	610	ELC40821107	400	6	390	260	115	21
SPDM850_F	850	850	ELC40821103	600	6	440	260	115	22
SPDM1M0_F	1000	915	ELC40821103	600	6	440	260	115	22
SPDM1M1_F	1100	1100	ELC40821104	1000	6	460	300	165	28
SPDM1K6_F	1650	1520	ELC40821104	1000	6	460	300	165	28
SPDM2K1_F	2100	2100	ELC40821105	1600	6	590	300	165	34
SPDM2K5_F	2500	2440	ELC40821105	1600	6	590	300	165	34
SPDM3K1_F	3100	2440	ELC40821105	1600	6	590	300	165	34
SPDM3K1_F	3100	3100	ELC40821106	2500	6	850	385	200	105
SPDM3K6_F	3600	3600	ELC40821106	2500	6	850	385	200	105
SPDM4K0_F	4000	3800	ELC40821106	2500	6	850	385	200	105

◆ RFI filter shall be optimized on the driven motor current $\mathbf{I_F = 0{,}82 I_{MOT\,max}}$ where the 0,82 factor take the current ripple into consideration

TA=40°C ➡ With greater operating temperature decrease the rated current by 1,25% per °C

Table E1.2

DRIVE		RFI FILTER (500V ±10% --50/60Hz ±4%)					
Type	Rated current	SAP code	Rated current	Leakage current	Dimensions (mm)		
	A		(IF) A	mA	L	A	P
SPAE1	10	ELC40969901	12	29	50	420	206
SPAE / SPAEB	10	ELC40969901	12	29	50	420	206
SPAM016U1D	16	ELC40824501 *	16	30	140	255	50
SPAM035U1D	35	ELC40969903	40	30	170	151	90
SPAM050U1D	50	ELC40732501	50	30	170	151	90

* Single phase Filter

TA=40°C ➡ With greater operating temperature decrease the rated current by 1,25% per °C

INSTALLATION SUGGESTIONS

MOUNTING PLATE AND PLACEMENT DEVICES

The mounting plate must be made from steel with zinc surfaces and without any painting. It shall be connected with PE copper bar by several bolts distributed in equal distances along the bar.

The RFI filter, the inputs reactors the fuses, the contactors and the drive must be placed on the mounting plate so that the connections can be made as short as possible, especially those from the drive via the input reactor to the RFI filter.

The surface of the components to be mounted to the mounting plate has to be free of coating material.

Components in the control cabinet (noise sources and receivers) must be physically separated, if necessary through the use of metal partitions or metal enclosures for individual components.

Contactors, relays, electromechanical hours counter, solenoid valves etc in the cabinet must be provided with quenching elements (RC, diodes, varistors etc). This devices must be connected directly at the coil.

CABLING

The cables for digital signals which are longer than 3m and all cables for analogue signals must be screened. Each screen must be connected at both ends by metals clamps or comparable means directly on clean metal surfaces, if both earthing points belong to the same earth line. Otherwise a capacitor (10 nF-2 KV) must be connected to earth on one end.

In the converter cabinet this kind of connection must be made directly on the sheet metal as close as possible to the terminals and if the cable comes from outside also on the PE bar. At the other end of the cable the screen must be well connected with the housing of the signal emitter or receiver.

While grounding the shields of the cables, it is necessary to use a 360° connection and it is compulsory to avoid a pigtail connection. By pigtail is meant the connection to earth ground of the cable shield by means of an additional wire.

Use a double-shielded twisted pair cable for analogue signals. This type of cable is recommended for the pulse encoder signals also. Employ one individually shielded pair for each signal.

Do not use common return for different analogue signals.

A double-shielded cable is the best alternative for low-voltage digital signals but single-shielded twisted multipair cable is also usable.



A double shielded twisted pair cable A single shielded twisted multipair cable

Run analogue and digital signals in separate, shielded cables.

Relay-controlled signals, providing their voltage does not exceed 48 V, can be run in the same cables as digital input signals. It is recommended that the relay-controlled signals be run as twisted pairs.

Never mix 24 VDC and 115 / 230 VAC signals in the same cable.

Maximum section of the control cables: 1,5mm2 (AWG16)

- Control signal cables must be kept at a distance greater than 0.3m (1 foot) from power cables. Keep both power cables and signal cables in separate raceways.
  If it is necessary to cross power and signal cables, cross at a 90° (right) angle.

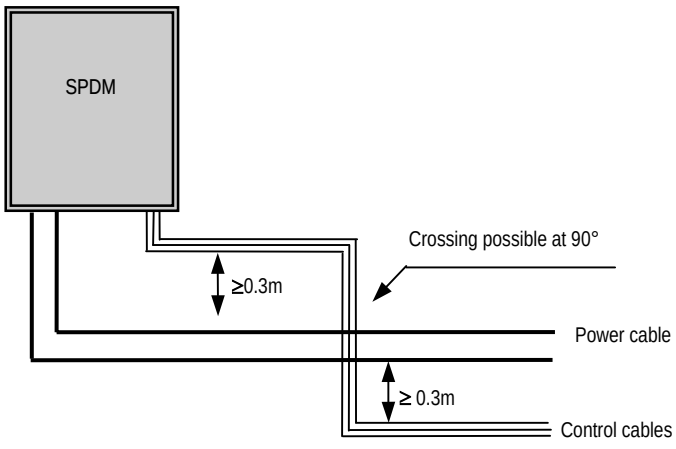


Figure E1.2. Cable Routing

POWER CABLES WITH SCREENS

Power cables with screens are necessary , if they run over long distances (greater than 20 m), where they are susceptible to EMC environmental conditions.
The transfer impedence ZT of the power cable must be less 0,1 Ω/m in the frequency range up to 100MHz, in order to ensure an effective reduction of emission and a significant increase of immunity.
The screen must be pressed by a well conducting metal clamp directly against the mounting plate of the PE bar of converter cubicle.
If it is not possible to use the shielded cables, use a pipeline/metallic raceway with a minimum covering of 80% and without interruptions, by connecting the side adjacent to the starting device to the earth bar of the panel.

RFI FILTER CONNECTION

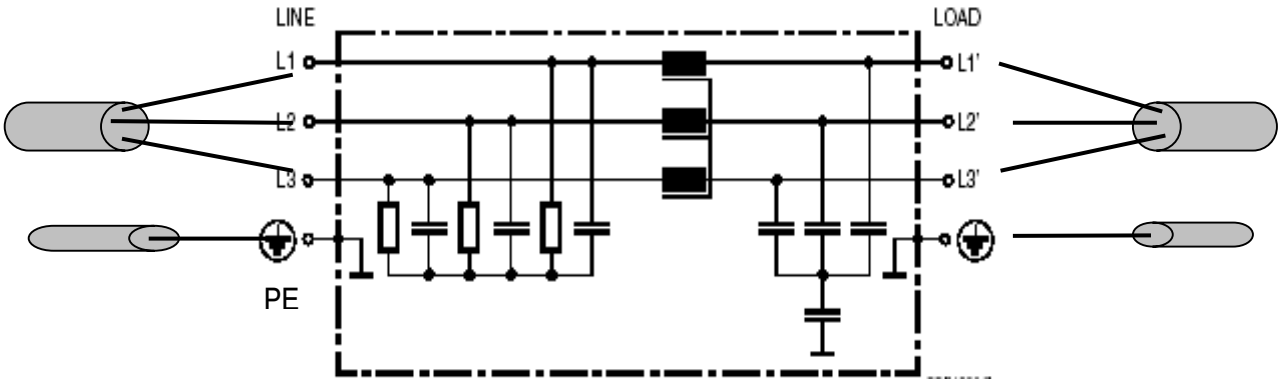


Figure E1.3 Drive connection

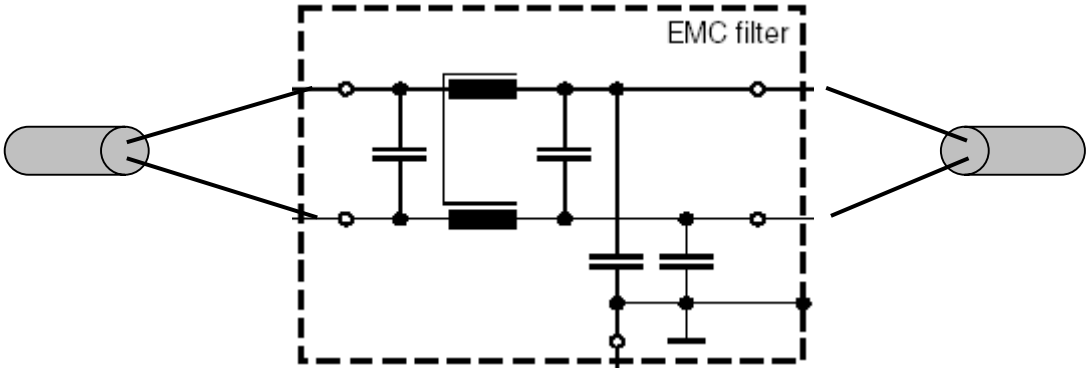
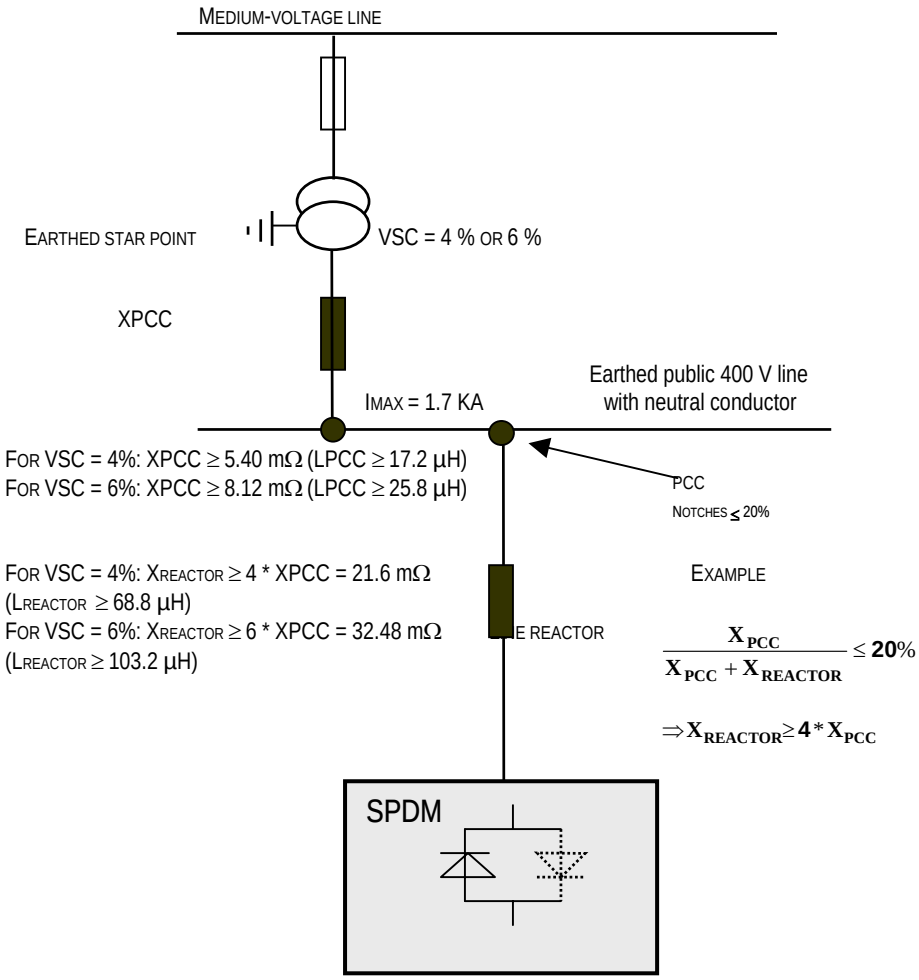


Figure E1.4 Exciter connection

LINE REACTORS

Converters cause short-duration short circuits at their AC inputs, called commutation notches. The depth of this notches must be reduced if the same transformer shall supply more than one converter. In such case line reactors are necessary.
They must cause about 2% relative voltage drop at rated current and are also necessary if the power of the converter is very low compared with the available power of the transformer or supply line.
According to the European product standard EN 61800-3, the commutation notches must be kept below 20% of the line voltage in the first environment, whereas an upper limit of 40 % is specified for the second environment. This target can be achieved with the aid of line reactors. The inductance of these reactors to be applied in the first environment must have 4 times the value of the network inductance at the converter's connection point (point of common coupling, PCC).

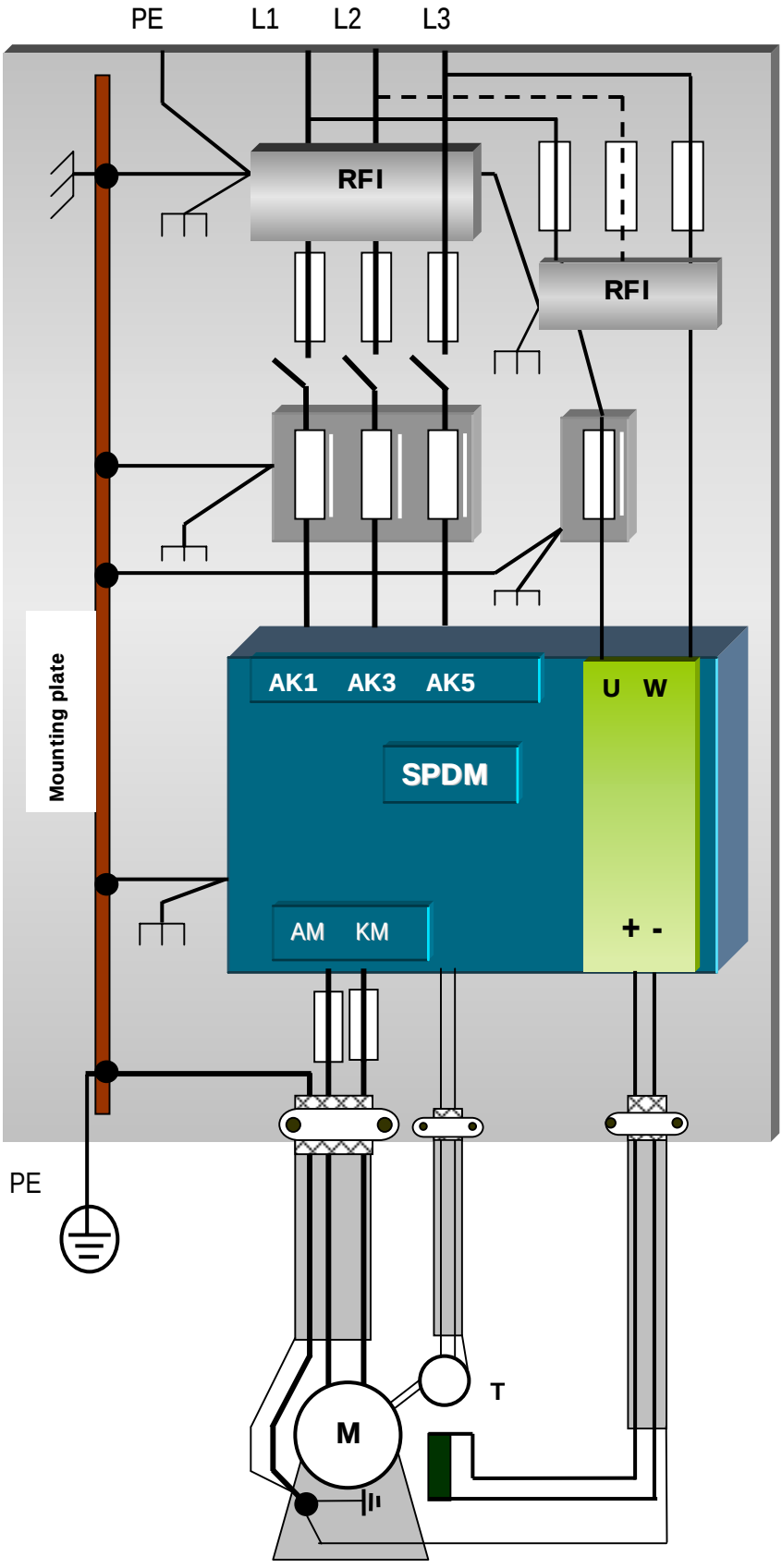
Due to the maximum power of public 400 V transformers (PMAX = 1.2 MVA -IMAX = 1732 A) and due to their relative short circuit voltage VSC of 4% or 6% the maximum AC current which is available for a converter is 520A or 346A (IDC ≤ 633A or 422A).
With reference to EN 61800-3 the rated power of transformer must be at least 4 times the rated power of the PDS.

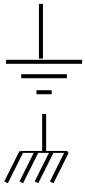

MEDIUM-VOLTAGE LINE
EARTHED STAR POINT
VSC = 4 % OR 6 %
XPCC
IMAX = 1.7 KA
Earthed public 400 V line
with neutral conductor
FOR VSC = 4%: XPCC ≥ 5.40 mΩ (LPCC ≥ 17.2 µH)
FOR VSC = 6%: XPCC ≥ 8.12 mΩ (LPCC ≥ 25.8 µH)
PCC
NOTCHES ≤ 20%
FOR VSC = 4%: XREACTOR ≥ 4 * XPCC = 21.6 mΩ
(LREACTOR ≥ 68.8 µH)
FOR VSC = 6%: XREACTOR ≥ 6 * XPCC = 32.48 mΩ
(LREACTOR ≥ 103.2 µH)
E REACTOR
EXAMPLE
$\frac{X_{PCC}}{X_{PCC} + X_{REACTOR}} \leq 20\%$
$\Rightarrow X_{REACTOR} \geq 4 * X_{PCC}$
SPDM

Required minimum line reactor impedance for installation of converter in first environment

Often the maximum current is not limited by the transformer but by the power cable to the industry region. Therefore it is necessary to ask the energy supply company concerning the line impedance and the current which is available at the desired point of common coupling (PCC).

FIRST CONNECTION EXAMPLE IN ACCORDANCE WITH EMC.





Earth, earthing for safety

Ground, grounding for EMC, connection with mass or housing with low inductance

Remarks.

Internal ground connections

Additionally to the PE connections good HF connections to the ground must be realized with the aid of a mounting plate which has a well conducting surface (sheet metal from zinc-plated steel for example).
The RFI filter, the inputs reactors and the drive must be pressed directly to the mounting plate by at least four fixing bolts, and the seating surfaces of the housings must be free from non conducting coating.
The PE bar must be connected with the mounting plate by many bolts which are distributed along whole length with equal distances.
All devices are connected with the PE bar by the mounting plate (and also by the PE conductors), and the PE bar is earthed via the PE conductor of the 3-phase power cable.

External earth connections.

The drive shall be earthed only by the earth conductor of the line cable; an additional local earthing, especially at the motor, raises the level of the RF noise on the line cable.

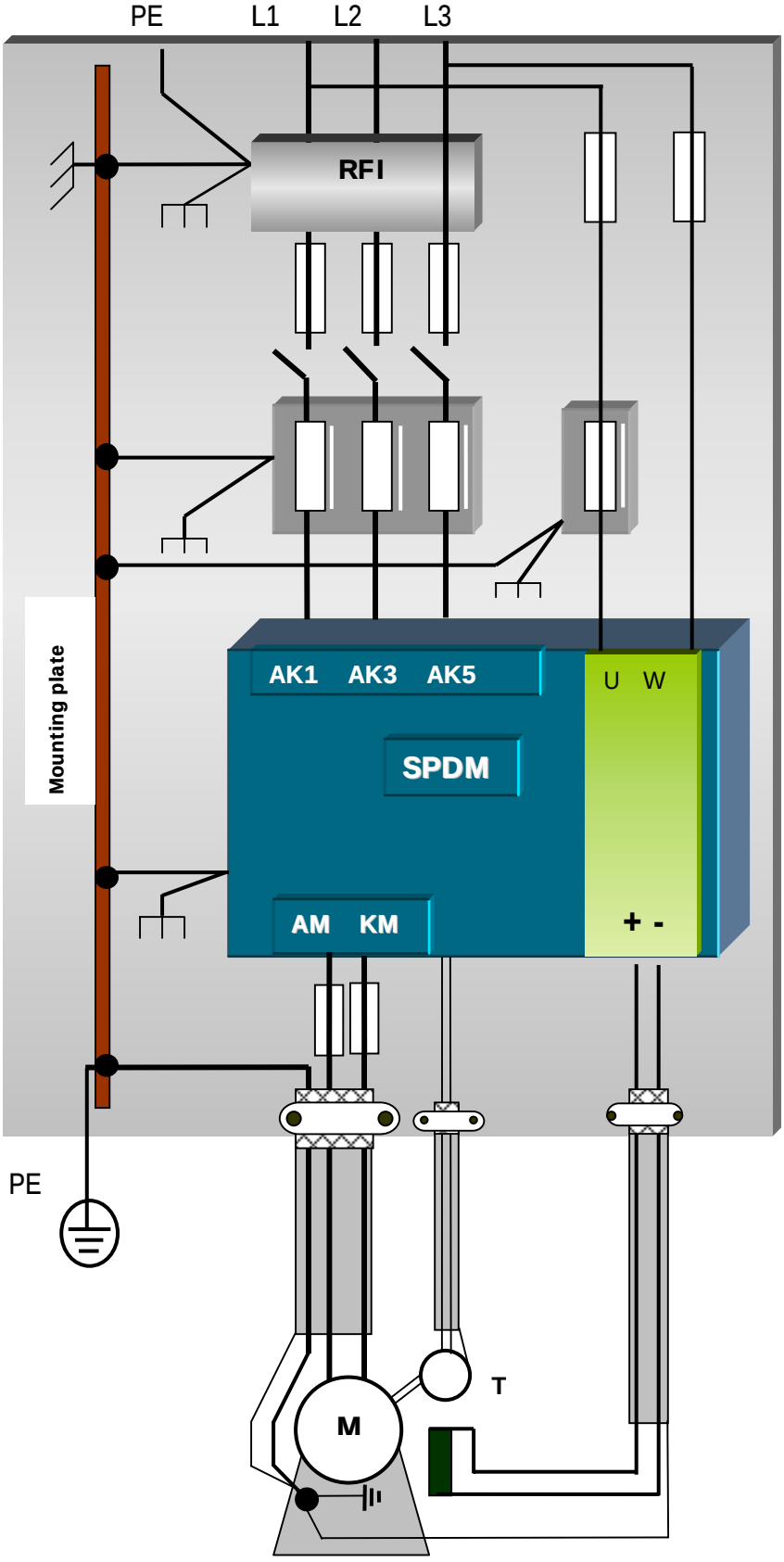
Earth connection between motor and driven machine

The earth of a grounded driven machine must be connected to the earth of the driving motor, in order to avoid floating potential.

Attention

The example shows the principle structure of a DC drive and its connections. It is not binding recommendation, and it cannot respect all conditions of a plant.
Therefore each drive must be considered separately and with respect to the special application. Additionally the general installation and safety rules must be taken in account.

SECOND CONNECTION EXAMPLE IN ACCORDANCE WITH EMC.



Earth, earthing for safety

Ground, grounding for EMC, connection with mass or housing with low inductance

Remarks.

Internal ground connections

Additionally to the PE connections good HF connections to the ground must be realized with the aid of a mounting plate which has a well conducting surface (sheet metal from zinc-plated steel for example).
The RFI filter, the inputs reactors and the drive must be pressed directly to the mounting plate by at least four fixing bolts, and the seating surfaces of the housings must be free from non conducting coating.
The PE bar must be connected with the mounting plate by many bolts which are distributed along whole length with equal distances.
All devices are connected with the PE bar by the mounting plate (and also by the PE conductors), and the PE bar is earthed via the PE conductor of the 3-phase power cable.

External earth connctions.

The drive shall be earthed only by the earth conductor of the line cable; an additional local earthing, especially at the motor, raises the level of the RF noise on the line cable.

Earth connection between motor and driven machine

The earth of a grounded driven machine must be connected to the earth of the driving motor, in order to avoid floating potential.

Attention

The example shows the principle structure of a DC drive and its connections. It is not binding recommendation, and it cannot respect all conditions of a plant.
Therefore each drive must be considered separately and with respect to the special application. Additionally the general installation and safety rules must be taken in account.

Appendix F PROFIBUS DP

F1. Introduction

The exchange of useful data between a Master and several slave drives is divided into two fields that can be transmitted in each telegram:

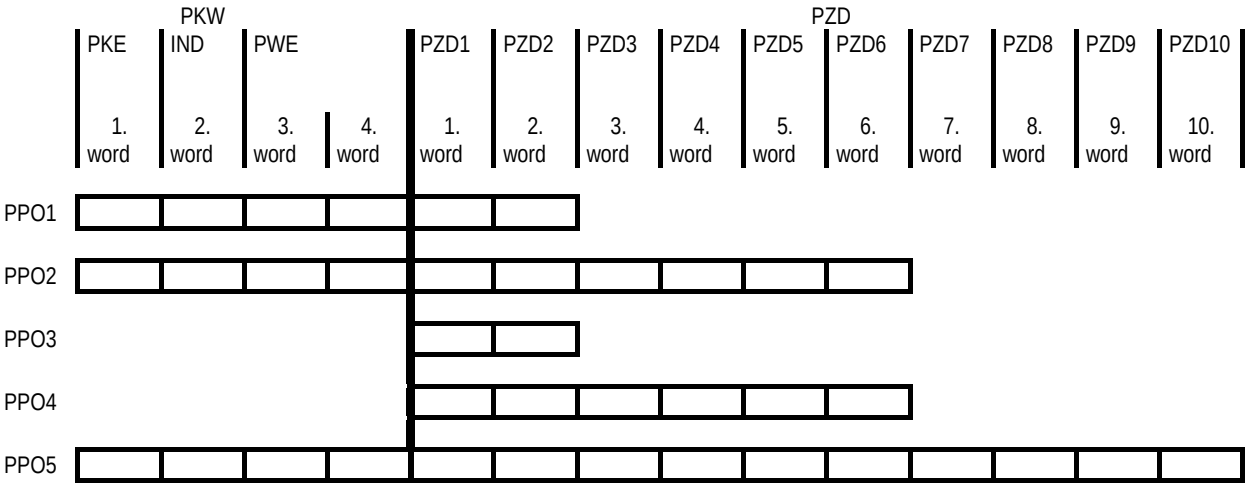
1. process data field: command words, drive status, reference values, reading of particular process variables (speed feedbacks, armature current, armature voltage,...).In any case this type of data is read and refreshed continuously at any refresh cycle of the drive main.

2. parameter field: these are drive variables which will be stored in EEPROM, therefore, they are written as a result of a change and after being tested for consistency. As far as the reading is concerned, the system supplies the value associated to the number of decimal digits, if any, and,if necessary, with the sign.

To optimise the time of Profibus bus cycle and compatibly with the task assigned to the various slaves, the user can choose a particular protocol among the five allowed ones, since each of these protocols is different according to the number of words exchanged.

F2. General description of the protocol

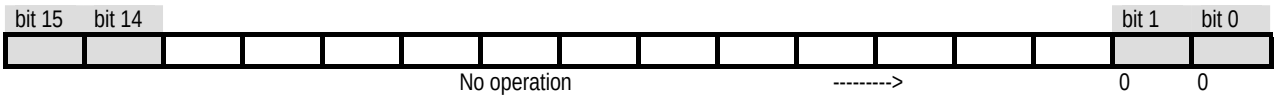
In the Profibus standard, the various types of messages which can be exchanged between a Master and the various slaves are called PPO (Parameter-Process data Object) and they make up the various protocols which can be chosen by the user.
Each PPO in its general form is divided into two parts: PKW and PZD.
The 'PKW' field is used to transmit and receive the configuration parameters of the Slaves (parameter field), while 'PZD' contains the process operation data (process data field).
Five types of PPO have been defined:



There is one PPO at Master input and one at Master output.

F2.1 Writing and reading modes of a field parameter

For this type of parameters, the commands sent by the Master to the slave are coded in the word 'PKE' in the part of message related to 'PKW' in the following way:

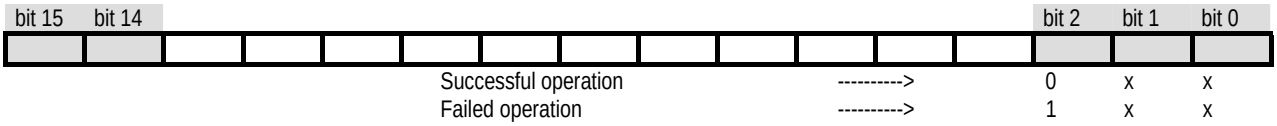


No operation	--------->	0	0
Parameter reading operation	--------->	0	1
Parameter writing operation	--------->	1	1
Special Commands	--------->	1	0

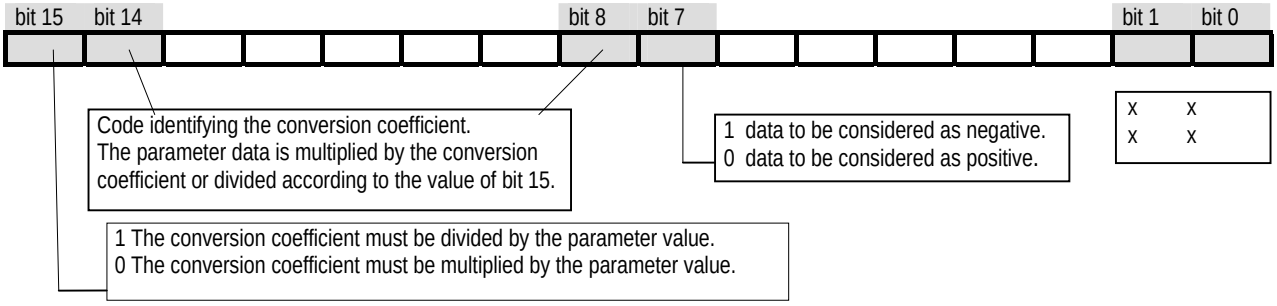
The second word 'IND' of the 'PKW' message contains the address of the parameter of the SPDM drive to be changed.
If the user chooses a writing command parameter, the third and the fourth word in the 'PKW' message contain the parameter value chosen, since the SPDM drive values are all 16 bit values, the fourth word will never be used (most significant word).
The parameter reading operation is a procedure similar to parameter writing.
After a reading or writing command, the 'PKW' part of the message concerning the PPO at Master input will contain the information related to the successful, or not, execution of the sent message.

The information will be grouped as follows:

The first word 'PKE' will contain the code of the requested operation with bit 2, if any, set to one if the previously requested operation is not allowed because a not existing parameter has been requested or because the user tried to set a value out of range:



In case of a parameter reading command, the above mentioned word, 'PKE' will contain further information about the type of parameter, negated data or not, and the number of digits after comma:


bit 15
bit 14
bit 8
bit 7
bit 1
bit 0
x x
x x
Code identifying the conversion coefficient.
The parameter data is multiplied by the conversion coefficient or divided according to the value of bit 15.
1 data to be considered as negative.
0 data to be considered as positive.
1 The conversion coefficient must be divided by the parameter value.
0 The conversion coefficient must be multiplied by the parameter value.

The current conversion codes implemented are:

0: conversion coefficient 1.
1: conversion coefficient 10.
2: conversion coefficient 100.

If the parameter reading was successful, the 'PKW' part of the message concerning the PPO at master input, that is the second word 'IND' will contains the address of the parameter and the third word('PWE' part) will contains the value of the parameter.

F2.2 Special Commands

For the special commands the following commands are coded as:

- Drive trace parameter request
- Thyristor Trace parameter request

F2.2.1 Drive trace and Thyristor Trace

The Traces are structured in records, from 0 to 49 for the Drives Trace and from 0 to 15 for the Thyristor trace.
A generic Drive Trace record is composed by the following fields:

Field n.0	n.1	n.2	n.3	n.4	n.5	n.6	n.7	n.8	n.9	n.10	n.11	n.12	Field n. 13	n.14	n.15
N & Status	Protections	Logic I/O	Aux1	Aux2	Aux3	No	N	Iao	Ia	Ud	Flu	Ifo	If	Uvo	Alfa

The meanings of the above-mentioned field are the follows:

- 'N & Status': are the record number and the drive status.
- 'N': record number respect to the block instant of the drive (record no.0)
- 'Status' : drive status
- 'Protections': protections status in case they should intervened
- 'Logic I/O': I/O logic status
- 'Aux1', 'Aux2', 'Aux3': auxiliaries variable contents
- 'No': speed reference
- 'N': spped feedback
- 'Iao': armature current reference
- 'Ia': armature current feedback
- 'Ud': armature voltage
- 'Flu': flux
- 'Ifo': field current reference
- 'If': field current feedback
- 'Uvo': line voltage
- 'Alfa': thyristor firing delay angle

A generic thyristor trace record is build as follow:

Field n.0	n.1	n.2	n.3	n.4
Iao	Ia	Alfa	T & S	Protections

The meanings of the above mentionated fields are the follow:

- 'Iao': armature current reference
- 'Ia': armature current reference
- 'Alfa': thyristor firing delay angle
- 'T & S': they're the thiristor number and the drive status.

These information are coded as follow: the thyristor number on the least significant byte and the drive status on the most significant byte.

- 'Protections': protections status in case they should intervened

F2.2.1.1 Commands coding

The coding layout is the follow:

word PKE:

bit 15	bit 14							bit 7	bit 6	bit 5	bit 4			bit 1	bit0
														1	0

Drive trace parameter request ----------> 0 0 0 1
Thyristor Trace parameter request ----------> 0 0 1 0

These two commands can request a parameter inside a definite record of one of the two chosen Traces. The choice of the parameter is done by giving the information of the:

- field related to the parameter inside the record
- record number

These two further information should be written in the 'IND' word as follow:

word IND:

bit 15							bit 8	bit 7						bit 1	bit 0

record number ----------> x x x x x x x x

x x x x x x x x <---------- Campo parametro

On the 'PKW' part of the chosen protocol reading are stored the results of the request done:

- the contents of the requested parameter is stored in the third 'PWE' word
- As eco-back copy of the 'IND' word previously requested is reported in the 'IND' word
- As eco-back copy of the 'PKE' word previously requested is reported in the 'PKE' word with the possible bit 2 setted to 1 in case of error in the request (record number out of range)
- If the record number is out of range, an error code is reported in the third 'PWE' word.

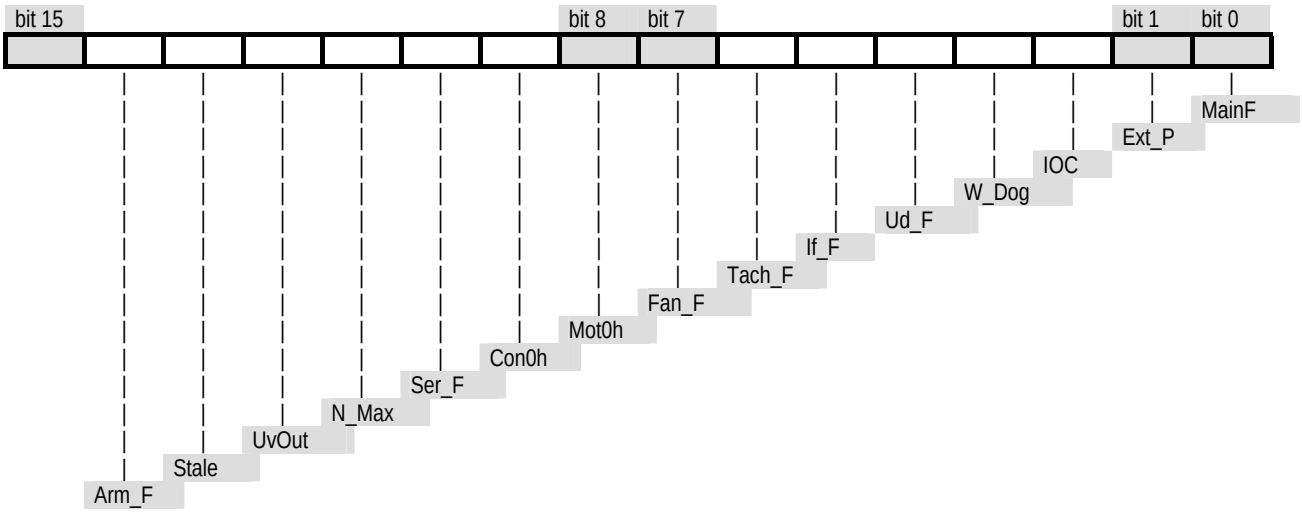
F2.2.1.2 Using of the record number

The relative record number exist only for the Drive Trace
The record number which appears in the field 0, has a temporaly meaning. Infact the record no.0 is the record of the instant when the protection is intervened, while the records with a positive number are the records stored in subsequent instans. The maximum number of these record is defined on the parameter DG1.
The remaining records are sorted according a negatives numbers decreasing order and they meaning the different storing instants, little by little more older since the protection has been intervened.
When the record number is requested in the 'IND' word, it means the offset compared with the oldest record, therefore an 0 offset means the oldest record stored, while a 49 offset means the latest record recorded and it depends from the DG1 parameter.
Because of the Thyristor Trace, the same method is used; the records number recorded in subsequent instants when the protection has been intervened and it's defined on the DG3 parameter of the 'IND' word.
It means the offset compared with the oldest record (offset 0). The offset 15 means the latest record and it depends from the DG3 parameters.

The word Protections which correspond to the field 1 of a generic Drive Trace record, has to be interpreted as follow

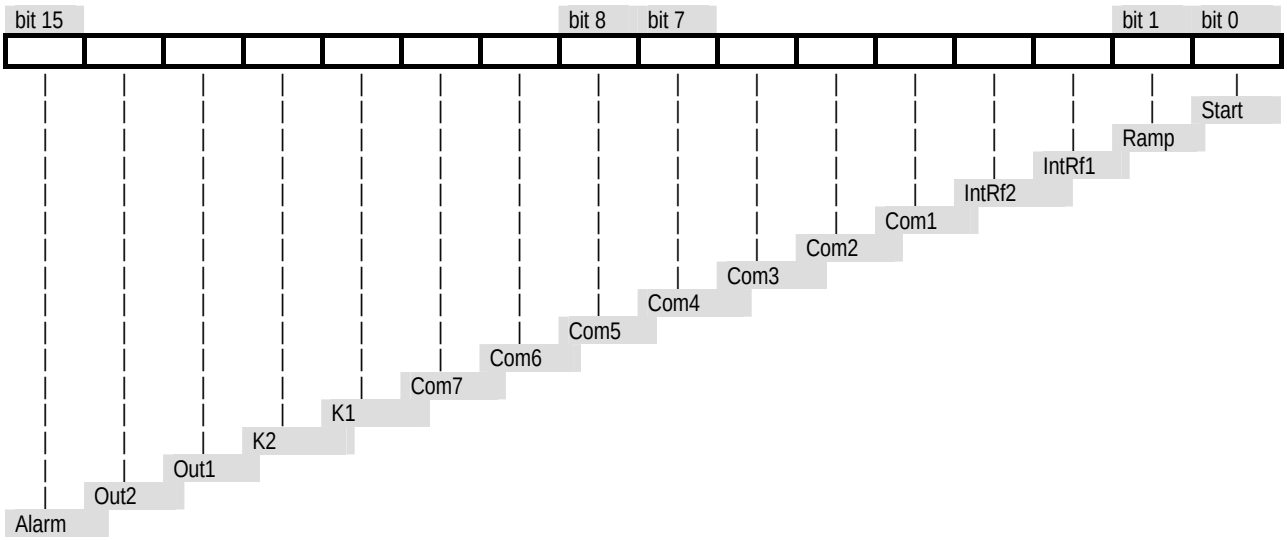
F2.2.1.3 Meanings of: Protections, Logic I/O, Drive Trace N & Status fields

Protections:



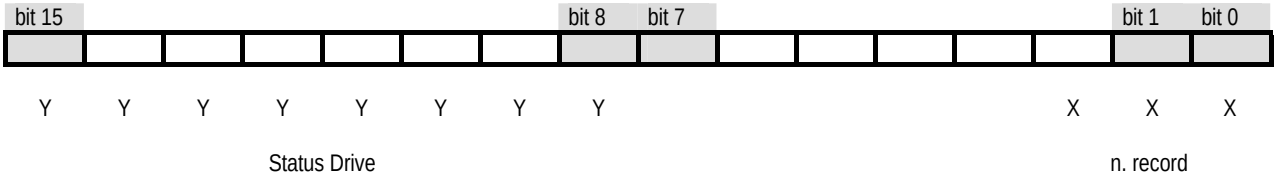
The 'I/O Logic' word which coincide to the field 2 of a generic Drive Trace record, has to be interpreted as follow:

Logic I/O:



The 'N & Status' word which coincide with the field no.0 of a generic Drive Trace record, has to be interpreted as follow:

N & Status:

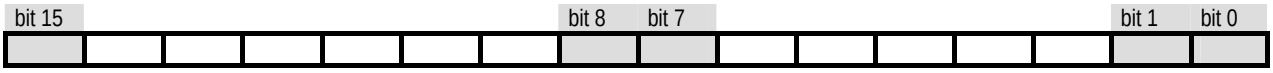


The Status Drive decoding is descripted on the paragraph F2.2.

F2.2.1.4. Significato campi: T & S, Protections del Thyristor Trace

The 'T & S' word which coincide with the field no.3 of a generic Thyristorn Trace record has to be interpreted as follow:

T & S:



Y	Y	Y	Y	Y	Y	Y	Y							X	X	X
			Status Drive												n. thyristor	

The Status Drive decoding is described on the paragraph 2.2.

The Protections word which coincide with the field no.4 of a generic Thyristor Trace record is the same word of the Drive Trace field no., described on the paragraph 2.1.1.3.

F2.3 Negative results of writing and reading commands

As a result of the above commands, the user can get error codes identifying the cause of the command failure.
If bit 2 of the 'PKE' word of PPO in reading is on, the command request contains an error.
The identification code of the error is written in the third word 'PWE' , while the word 'IND' will contain the address of the involved parameter.

The error codes currently implemented are:

Error code	Meaning
1	Parameter out of range
2	The data does not exist
3	Parameter consistency error
4	Data not allowed in profibus exchange

The above situation is frozen in the previously mentioned words until the master user sends the correct values.

F2.4 Process parameters

The process parameters which are the PDZ part of the PPO message chosen, are always exchanged between Master and slaves.
The first two words have the following meaning:

for PPO at Master input:

- word n. 1: drive status.
  Bits status:

1	x	x	A	B	C	D	E	Test status. Bits A,B,C,D,E define the failed test.
0	1	x	A	B	C	D	E	Protection status – Bits A,B,C,D,E define the protection intervened.
0	0	1	A	B	C	D	E	Suppr. Status. Bits A,B,C,D,E define the suppression cause.
0	0	0	1	0	0	A	B	Zero speed adjust. status.
0	0	0	0	1	0	A	B	Speed forward adjust. status.
0	0	0	0	0	1	A	B	Speed backward adjust. status.
								If bit A is high, the Drive has an active alarm.
								If bit B is high, the Drive is in limit of current.

Decoding of Test status:

0	0	0	0	1	Lack of synchronism.
0	0	0	1	0	Phase detecting circuit broken.
0	0	0	1	1	Network out of tolerance.
0	0	1	0	0	Network frequency out of tolerance.
0	0	1	0	1	Drive identification number is zero. (par. DA1).
0	0	1	1	0	EEPROM broken.
0	0	1	1	1	Armature current not null.

Decoding of Protection status:

0	0	0	0	1	Lack of network.
0	0	0	1	0	External protection.
0	0	0	1	1	Max. instant current.
0	0	1	0	0	Watchdog intervention.
0	0	1	0	1	Max. armature voltage.
0	0	1	1	0	Lack of motor field.
0	0	1	1	1	Tachym. Failure.
0	1	0	0	0	Lack of ventilation.
0	1	0	0	1	Motor thermal protection.
0	1	0	1	0	Converter thermal protection.
0	1	0	1	1	Serial failure.
0	1	1	0	0	Motor max. speed.
0	1	1	0	1	Network out of tolerance.
0	1	1	1	0	Motor in stall.
0	1	1	1	1	General failure.

Decoding of Suppression status:

0	0	0	0	1	Terminal XM1-19 disabled.
0	0	0	1	0	Terminal XM1 - 13 disabled.
0	0	0	1	1	Disabling generated by serial.
0	0	1	0	0	Disabling generated by optional function.
0	0	1	0	1	Disabling generated by internal PLC.

- word n. 2: speed feedback.
  The data is expressed in the scale CCCDH - 3333H and for the master it's to be meant as an integer signed word and, due to the decimal, a data between -13107 and +13107 will be read.

for PPO at Master output:

- word n. 1: logic commands in and with corresponding physical commands of the terminal board, enabled from SPDM keypad.
  It's the least significant byte of the word (bit = 0: not active command; bit = 1: active command).

Bit 0	Start command	Corresponds to terminal XM1-13.
Bit 1	Ramp command	Corresponds to terminal XM1-14.
Bit 2	Intrf1 command	Corresponds to terminal XM1-15.
Bit 3	Intrf2 command	Corresponds to terminal XM1-16.
Bit 4	Com1 command	Corresponds to terminal XM1-17.
Bit 5	Com2 command	Corresponds to terminal XM1-18.
Bit 6	Com3 command	Corresponds to terminal XM1-19.

- word n. 2: speed reference or current reference, can be chosen in the menu using the SPDM keypad.

The data is expressed in the scale CCDH - 3333H and for the master it's to be meant as an integer signed word and, due to the decimal, a data between -13107 and +13107 will be written.

The meaning of these two words is fixed for all the five PPO messages.

The other words can be chosen by the user by enabling the proper masks from the SPDM keypad.

Currently, a maximum of 8 words can be chosen for process data both for PPO in writing or PPO in reading.

For PPO in reading, the data exchanged by reading for the master are the same described in the group F of the paragraph 3.2

For PPO in writing, the data exchanged in writing for the master are only:

- replacement of analog input 'Ean1' with reference coming from Profibus.
  Once this reference is enabled, the real replacement of the analog input 'Ean1' is determined by the choice of 'Ean1' for those parameters which include this term as a choice, in am mutually exclusive way.
  The reference 'Ean1' via Profibus finds no useful destination, but it's exchanged anyway, even if, though enabled, it has not been chosen by any of the parameters which foresaw it as a possible choice.
  The data is an integer signed word included in the range between CCCDH - 3333H
  (that is from -13107 to + 13107, due to the decimal).

- replacement of analog input 'Ean2' with reference coming from Profibus.
  See the above point.

- Display of variable 'Aux1' written by a Profibus Master. This variable is useful for debugging since it allows to display, through the SPDM keypad operator interface or any analog output PWM1 or PWM2 or PWM3, a parameter of the application residing in the Profibus master, only for debugging.

This type of data will be refreshed by the drive only when the master has set the bit 15 to on in the command word (first word of PZD).

F2.5 DIGITAL OUTPUTS CONTROL BY PROFIBUS

The digital output control can be done directly by the command words (PZD1 word) sent to the drive by Profibus. The command word is the following:

Bit 0	Start Command	Corrisponde al morsetto XM1-13.
Bit 1	Rampa Command	Corrisponde al morsetto XM1-14.
Bit 2	Intrf1 Command	Corrisponde al morsetto XM1-15.
Bit 3	Intrf2 Command	Corrisponde al morsetto XM1-16.
Bit 4	Com1 Command	Corrisponde al morsetto XM1-17.
Bit 5	Com2 Command	Corrisponde al morsetto XM1-18.
Bit 6	Com3 Command	Corrisponde al morsetto XM1-19.
Bit 7	Protection Soft reset	
Bit 8	Digital output OUT1 forging (terminal XM1-24)	
Bit 9	Digital output OUT2 forging (terminal XM1-25)	
Bit 10	Digital output OUT3 forging (terminal X1-9/10/11 SPDIO expansion board)	
Bit 11	Digital output OUT4 forging (terminal X1-12/13/14 SPDIO expansion board)	
Bit 12	Digital output OUT5 forging (terminal X1-15/16/17 SPDIO expansion board)	
Bit 13	Digital output OUT6 forging (terminal X1-18/19/20 SPDIO expansion board)	
Bit 14	Not used	
Bit 15	Command enabling.	

The protection soft-reset do not act on the P-0, P-2 and P-3 protections. This protections are very important for the drivew and are stored on the control board hardware. So to reset this protections it is necessary to reset the board.
Setting the parameter DEE=ON, the reset made by the bit 7 of the command word will become an hard-reset, (i.e it resets the hardware protections of the board).
WARNING! The HW reset takes place if the commands from Profibus are enabled (DEB=ON) only.
The digital output can be forced if its corresponding parameter is set to 'Profib' only.
For the output OUT1 it is necessary to set DO1=Profib
For the output OUT2 it is necessary to set DO2=Profib
And so on.

F3 Use modes

F3.1. Hardware components

The Profibus protocol requires a Profibus interface board, a SPDM drive with EPROM suitable for the protocol management.
Serial cables, equipped with connector, compatible with SINEC L2-DP Siemens connector (baud rate up to 1500Kbaud), or anyway connectors compatible with the Profibus DP Standard (DIN 19245 standard, part 3).

F3.2. User interface

To enable and set-up the data related to the Profibus protocol, the user needs of the SPDM keypad user interface.
For the reception, from the Profibus interface board, of the following set-up parameters it is necessary an hardware reset of the drive.
The data group involved to set the set-up data is the Drive Parameters E group.

Group E - Serial Link

DEA	Profib	OFF	ON/OFF	Enabling of Profibus protocol.
DEB	S_Com	OFF	ON/OFF	Enabling of logic commands via Profibus; these commands are in and with the corresponding physical commands (terminals XM1-13, 14, 15, 16, 17, 18, 19).
DEC	S_ComD	OFF	ON/OFF	Disabling of logic commands via serial link; if DEC is on the system, in case of serial failure, disables automatically the DEB parameter, keeping active only the physical commands. In this way, it's allows to use the manual emergency commands. The disabling of par. DEB is stored in eeprom.
DE1	Ptcol	PPO1	PPO1 PPO2 PPO3 PPO4 PPO5	Types of protocols
DE2	StAdd	3	3 - 32	Range of choice of station number (it starts with 3 because the slaves in case of a PLC Siemens - Simatic are seen beginning with station n. 3).

The following group manages the setup of the enabling of process data which can be exchanged between a master and the slaves.
Group F - Serial Data
The following group of process data is considered in reading for a Master.

DFA	D1RnSt	OFF	ON/OFF	Registration No. + Status
DFB	D1RPro	OFF	ON/OFF	Protections
DFC	D1RAbi	OFF	ON/OFF	Logic I/O
DFD	D1RAu1	OFF	ON/OFF	Auxiliary variable AUX1
DFE	D1RAu2	OFF	ON/OFF	Auxiliary variable AUX2
DFF	D1RAu3	OFF	ON/OFF	Auxiliary variable AUX3
DFG	D1RNo	OFF	ON/OFF	Speed reference No.
DFH	D1R_N	OFF	ON/OFF	Speed reaction No.
DFI	D2RIao	OFF	ON/OFF	Armature current reference
DFJ	D2R_Ia	OFF	ON/OFF	Armature current reaction
DFK	D2R_Ud	OFF	ON/OFF	Armature voltage
DFL	D2Rflu	OFF	ON/OFF	Motor current flux
DFM	D2RIfo	OFF	ON/OFF	Motor current flux reference
DFN	D2R_If	OFF	ON/OFF	Motor current flux reaction
DFO	D2RUvo	OFF	ON/OFF	Line voltage
DFP	D2R_alfa	OFF	ON/OFF	Thyristor firing delay

The following group of process data is considered in writing for a Master:

DFa	D1WEn1	OFF	ON/OFF	Analog input 'Ean1' from Profibus
DFb	D1WEn2	OFF	ON/OFF	Analog input 'Ean2' from Profibus
DFc	D1WAu1	OFF	ON/OFF	Variable 'Aux1' from Profibus

The second word of the PDZ part of message chosen in writing for the master, speed reference or current reference, depends on the setup of the configuration parameter 'CB1' for the speed reference (automatically set upon enabling of the Profibus protocol in serial item), and 'CA1' for the current reference which, if set in serial item, automatically disables the 'CB1' parameter (only if the Profibus is enabled).

F3.3 Description of field parameters

See section B
The user can both read and edit a parameter. All the parameter are accessibles from the profibus except the parameters used by the communication.
These are, in the Profibus protocol, the parameters DE0, DE1, DE2, DF0 which addresses on the table are 582, 583, 584, 594, 595.
They can be changed only by the keypad, as explained on the paragraph F3.2.
In case of modify via Profibus, the error no.7 will be reported.

F4. Diagnostic

F4.1 Serial failure

The serial failure protection cannot be disabled. If the serial link is interrupted, the Profibus interface board detects the lack of query from the master and informs about the event through the Ram Dual Port in the SPDM drive.
The drive makes the protection intervene and checks, if the logic commands have been enabled from Profibus, to be in and with the physical commands on the terminals (parameter DEB 'S_Com' ON) XM1-13, 14, 15, 16, 17, 18, 19; in this case, it checks whether the parameter DEC 'S_ComD' is ON and only in this case disables the logic commands coming from Profibus by setting automatically the DEB 'S_Com' OFF. This allows to use the emergency manual commands without being in and with those coming from the Profibus.

F4.2 Drive off

If a drive is off, the Profibus interface board, which is supplied by the drive since it's interfaced by means of a drive connector, is off too. In this situation the Profibus Master detects the slaves which are not communicating and performs the diagnostic according to the DIN 19245 standard, part 3, which contain the information about the type and which slaves are not working properly.

F4.3 Profibus board broken

The SPDM drive always controls the exchange activities with the Dual Port Ram; at the end of these activities, it issues a serial failure event and behaves as required.

F5. Changes on this release

The modifications of this release will be reported to the next SPDM drive without profibus.
The modify involve the follows parameters:

- the DOA, DOB, DOC, DOD, DOE, DOF parameters can be changed during the drive regulation status.

F6. Profibus interface board

The eprom code for the SPDM profibus interface is D005X9FX.

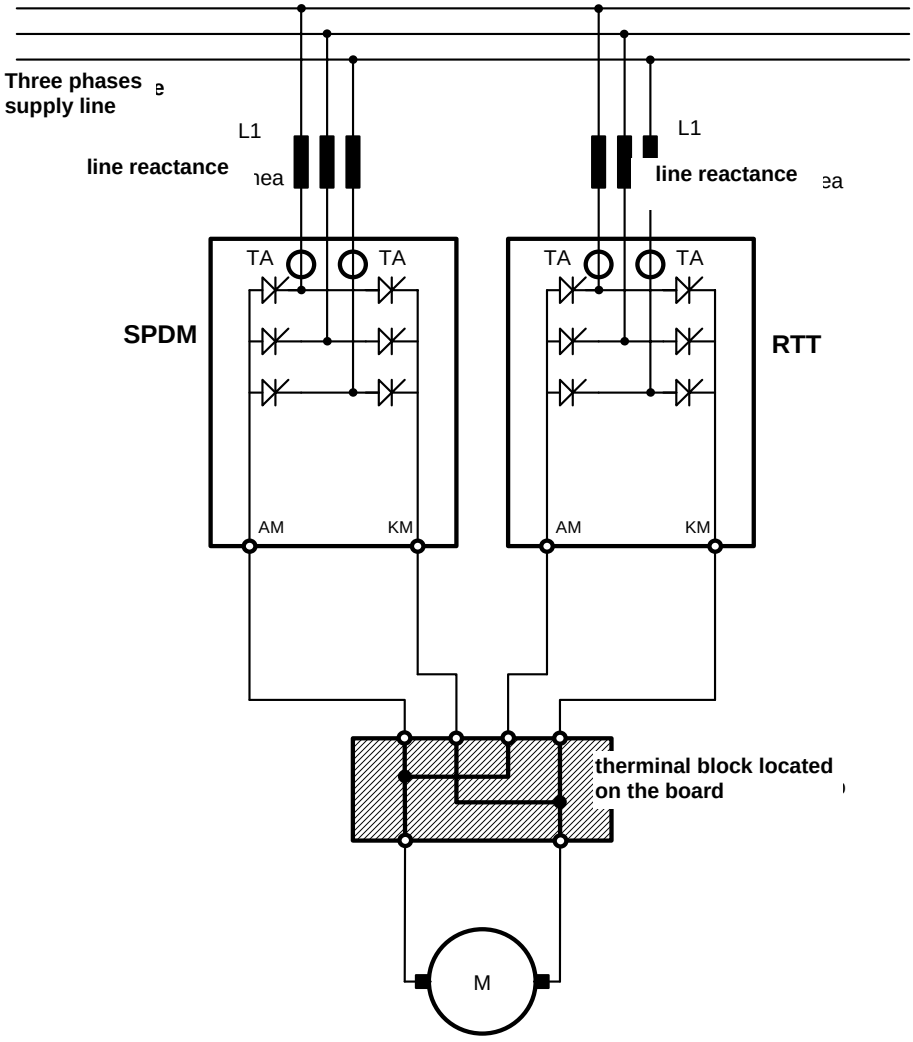
APPENDIX G PARALLEL OF BRIDGES

In order to increase the output current of the SPDM converters it is possible to parallel one SPDM suitably arranged, with a module called RTT.
The SPDM suitable for parallel connection is identified by suffix 20 and it has a PPRCRD board installed inside.
The RTT is a SPDM without the control board and with the PPRCRC board installed inside.
The parallel connection between the SPDM and the RTT is made in the following way:

a connecting the SPDM terminal KM to the RTT terminal KM and the SPDM terminal AM to the RTTterminal AM.
For the connections it is necessary to use as a support a terminal block located on the board itself. The layout of the connections between the converters and the supporting terminal block must be as symmetrical as possible and cables must be of the same type.

b both SPDM and RTT must have the input reactor. The reactance value must have a voltage drop at the rated phase current (I_{LN}=0,82I_N) between 2% to 4% of the phase voltage

The maximum distance between SPDM and RTT, imposed by the flat-cable length used to connect the PPRCRC and PPRCRD, is about 2 m.
The parallel connection must be made using an SPDM and an RTT of the same size.

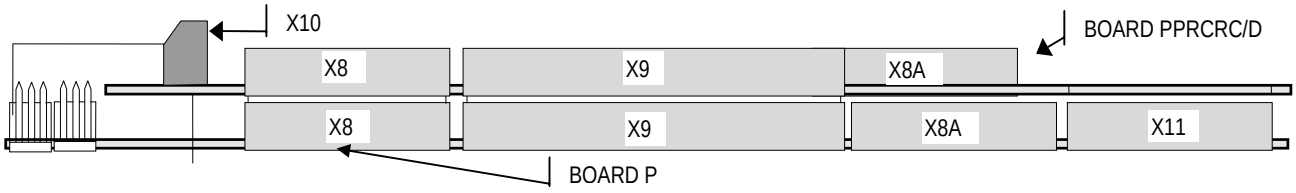


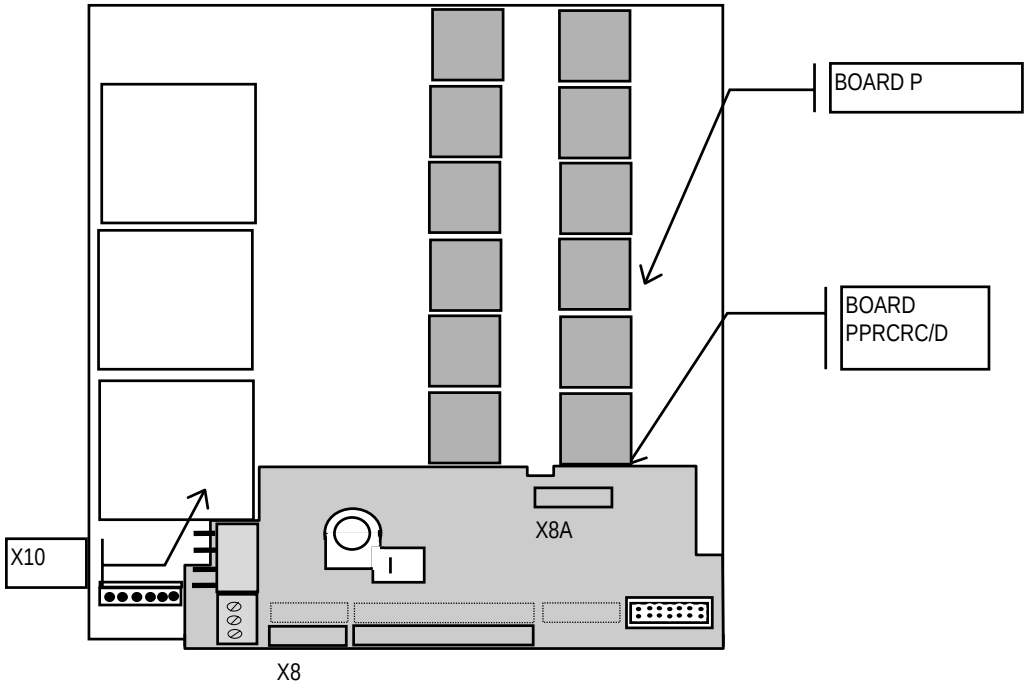
The board PPRCRC and PPRCRD use the same printed board and differ from the quantity of the components installed.

DESCRIPTION OF THE PPRCRC/D BOARDS

The PPRCRD board is fitted onto the SPDM P boards by means of the relevant connectors and spacers; likewise the PPRCRC board is fitted onto RTT P board.
The C board of the SPDM will no longer be connected to the P board, but to the PPRCRD board through the connectors, which keep the same codes as before.
The two PPRCRC and PPRCRD boards are connected to each other by a flat cable (X8A connectors). It is also necessary to connect the Faston terminal XT5 of the PPRCRC/D boards by cable to the Faston terminal X5 of the P board.
The lack of a connection between the PPRCRC and PPRCRD boards through flat cable X8A prevents the operation of the converter (Fan_F thermal protection).
On the PPRCRC board the jumper CV3 must be closed; whereas on the PPRCRD board the jumper CV1 must be closed.

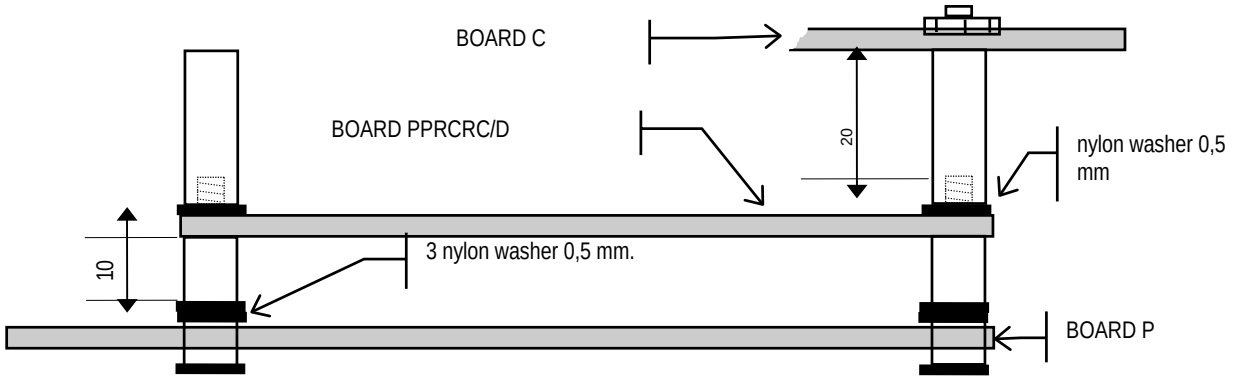
BOARD LAYOUT.



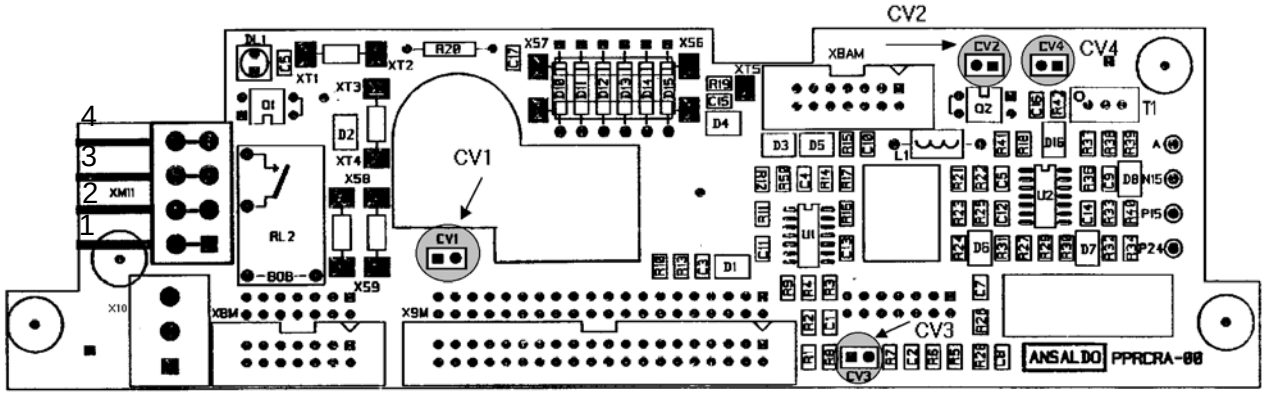


FIXING THE BOARD

In order to fix the PPRCRC/D board to the P board and subsequently (where required) the C board to the PPRCRD board, nylon threaded spacers are used, as shown in the following drawing.

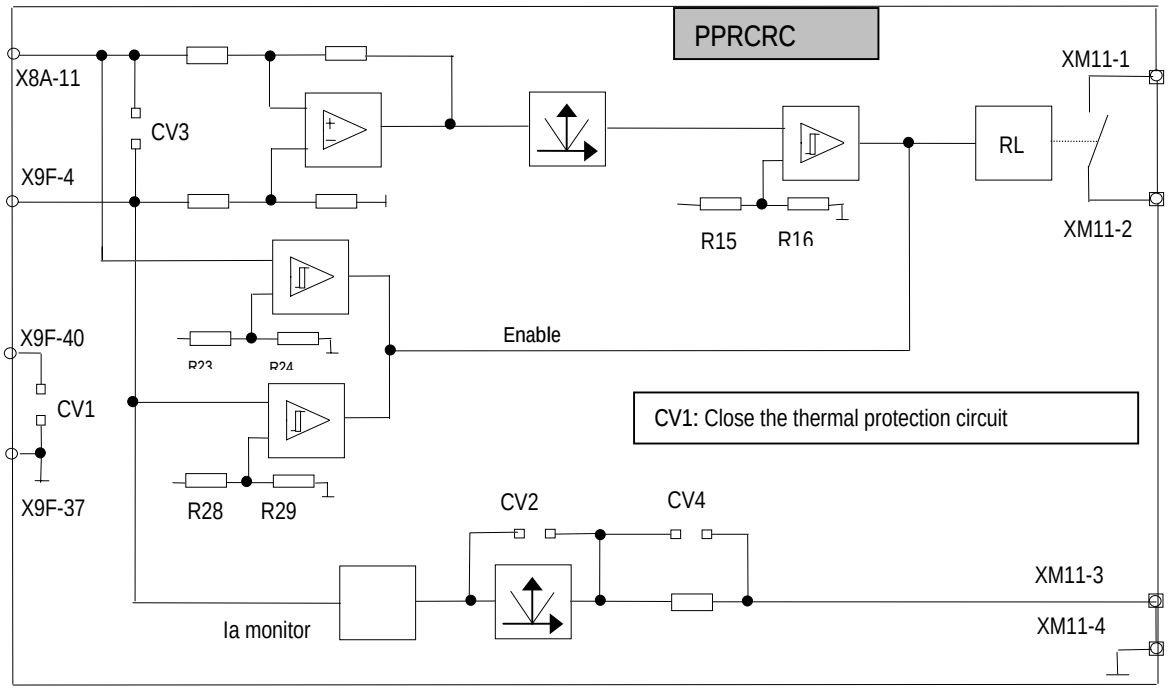


SERIGRAPH = PRINTED CIRCUIT BOARD



XM11 = Four-pole Faston terminals X10 = Three-pole terminal, not in use.	x58 - 59	Jumper.	CV1	Jumper open
	xT1 – xT2	Resistor 22 KΩ.	CV2	Jumper open
	xT3 – xT4	Resistor 22 KΩ.	CV3	Jumper closed
	xT6 – xT7	Resistor 22 KΩ.	CV4	Jumper open

The board PPRCRC, installed on RTT, compares the IAM current delivered from the MASTER (SPDM) with the current delivered by the SLAVE (RTT). If the difference between the two currents exceeds the permitted tolerance, the comparison relay drops out.
The protection will not be activated until the current of a bridge reaches its nominal value.
The circuit of the Ia monitor of the RTT is present on the PPRCRC board, (for the SPDM the output XM1-35, 36 is to be used) with outlet at the Faston terminals XM 11-3,4. A d.c.ammeter may be connected to these terminals with 5 mA full scale or a d.c. voltmeter with 10 V full scale.
The output can be set with the T1 trimmer.
Should a voltmeter be used, the CV4 jumper must be closed.
The output from the Ia monitor can be at a relative value (CV2 jumper closed, instrument at central zero) or at absolute value (CV2 open, instrument at side zero).

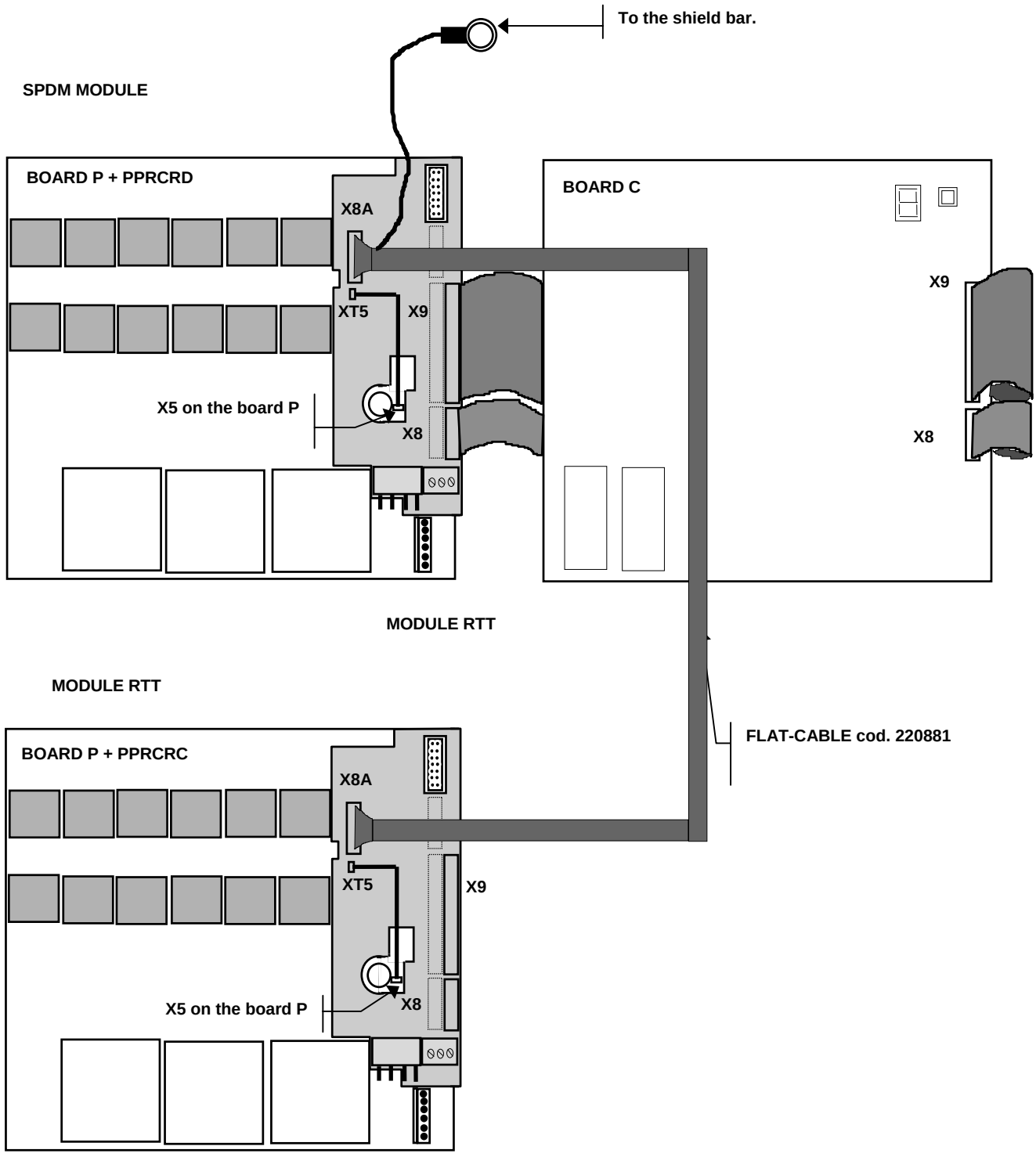


PPRCRA BOARD OUTPUT TERMINALS

TERMINAL	DESCRIPTION
XM11-1	N.O. contact of the 4A 240V ac relay; open contact = protection triggered..
XM11-2	N.O. contact of the 4A 240V ac relay; open contact = protection triggered..
XM11-3	Ia monitor positive output
XM11-4	Ia monitor earth

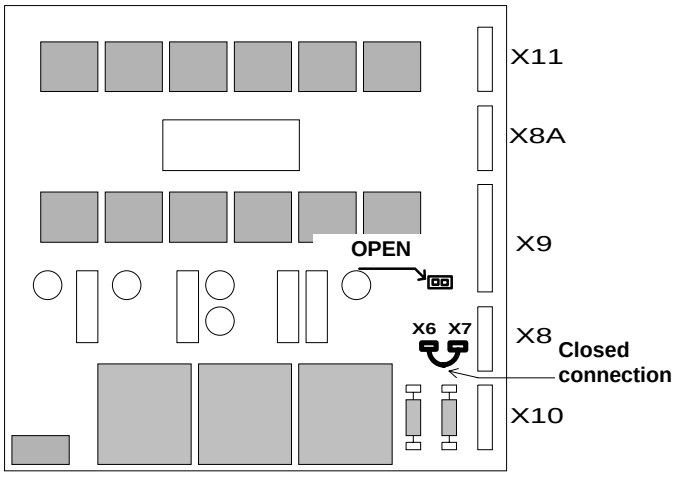
The maximum distance between the SPDM and RTT modules in the board is set by the length of the flat cable used for the

CONNECTING THE BOARDS



The load distribution between the two bridges depends on the electrical specifications of the line circuit: line inductance - motor armature. The current regulator is located in the SPDM converter that receives the signal relating to the current reaction through its transduction circuit (TA - Load resistors); the circuit of the TA, installed on board of the RTT module, monitors the current signal of its own bridge for the IOC (instantaneous over-current) protection of that branch of the parallel.

The connection on the P board of the module SPDM and of the module RTT must be closed between the terminals X6 and X7, and the JP1 jumper must be open, as shown in the illustration below:



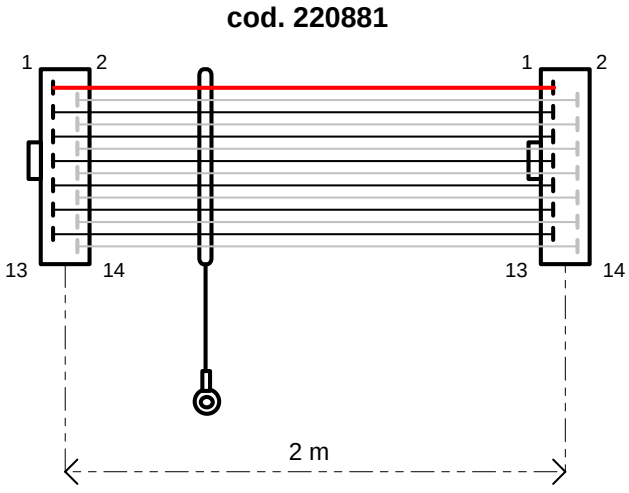
On the PPRCRC board fitted on the RTT module, the jumpers must be personalized, as shown in the following table:

JUMPER	POSITION	DESCRIPTION
CV1	OPEN	
CV2		NOT USED
CV3	CLOSED	
CV4		NOT USED

On the PPRCRD board fitted on the SPDM module, the jumpers must be personalized, as shown in the following table:

JUMPER	POSITION	DESCRIPTION
CV1	CLOSED	
CV2		Open if Ist monitor output in absolute value is required, otherwise it must be closed.
CV3	OPEN	
CV4		Open for Ist monitor output as a current signal (5mA limit), closed for a voltage signal (10V limit).

The command impulses of the bridge generated by the SPDM converter are also sent to the RTT module through a shielded flat cable fitted with 2 female connectors (14 pins) connected to the X8A connectors and fitted on the PPRCRC and PPRCRD boards, the flat cable shield must be connected to the relevant bar of the shields on the SPDM module. The flat cable must follow a dedicated route which should be as short as possible (max. 2 meters) in metal channelling connected to earth (cable code 220881).



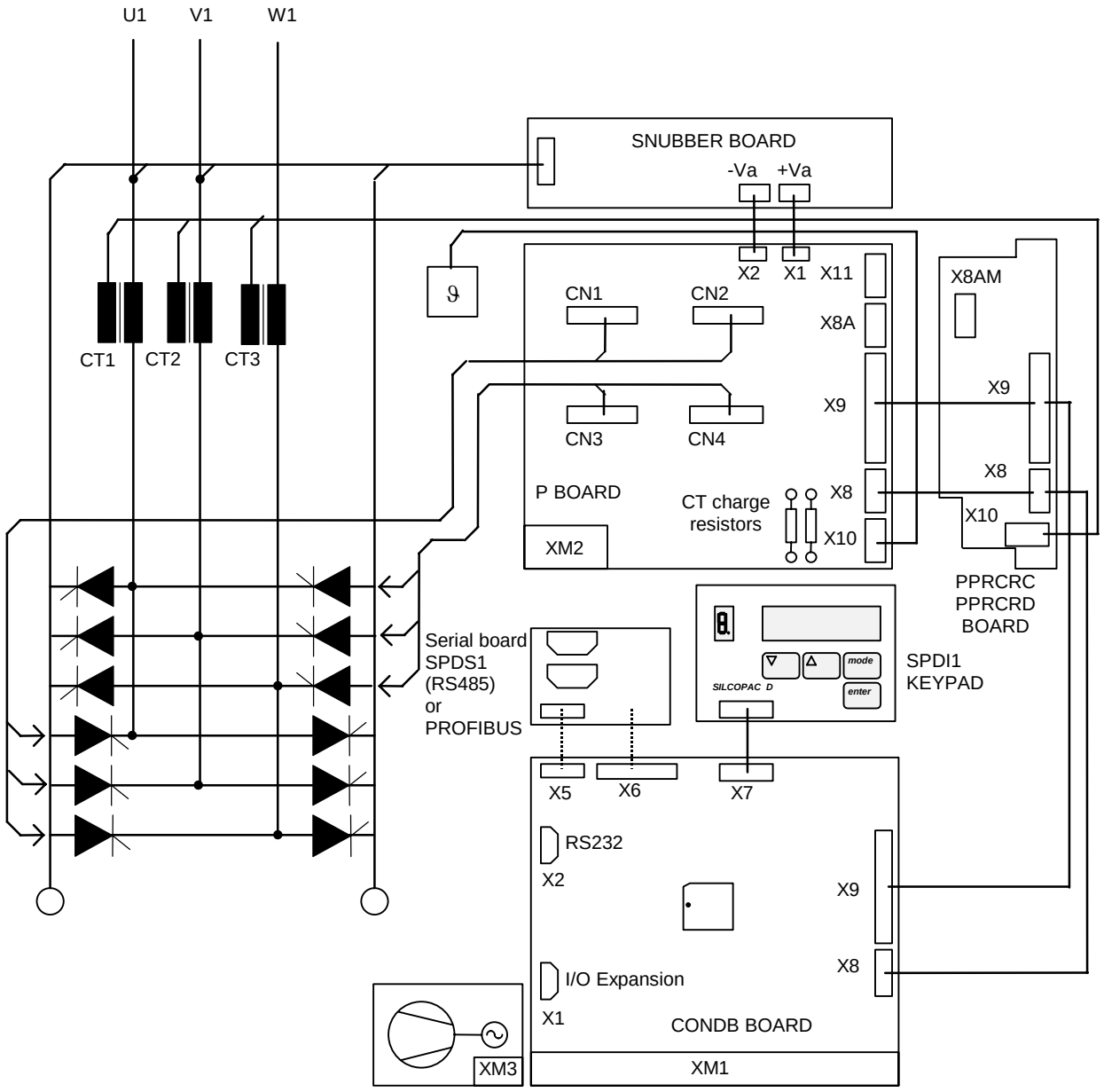
IOC PROTECTION

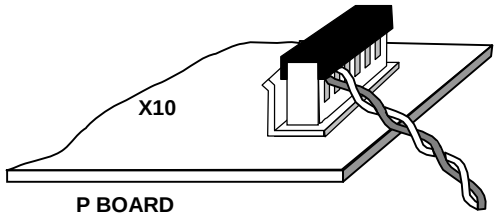
The RTT module does not have the C board on board. The connection between the X6 and X7 terminals of the P board must be closed.
The armature current transducer (TA + load resistors) of the RTT module acquire nevertheless a signal proportional to it, so that it can be monitored by the IOC (instantaneous over-current) protection circuit. The control on board of the SPDM module receives this signal through the flat cable (Code 2208881).

VENTILATION FAILURE PROTECTION

The status of a lack in ventilation is monitored for each of the two modules (RTT and SPDM) by the respective thermal sensors.
The thermal pins offer a normally closed contact. It is therefore necessary to make a series circuit between the contacts of the thermal pins, so that the control can sense either of them being triggered. All the connections necessary to create the series circuit are automatically created by flat cable between the two connectors X8A of the PPRCRC and PPRCRD boards (the CV1 jumper on the PPRCRD board must be closed).

Version with trhee current transducers

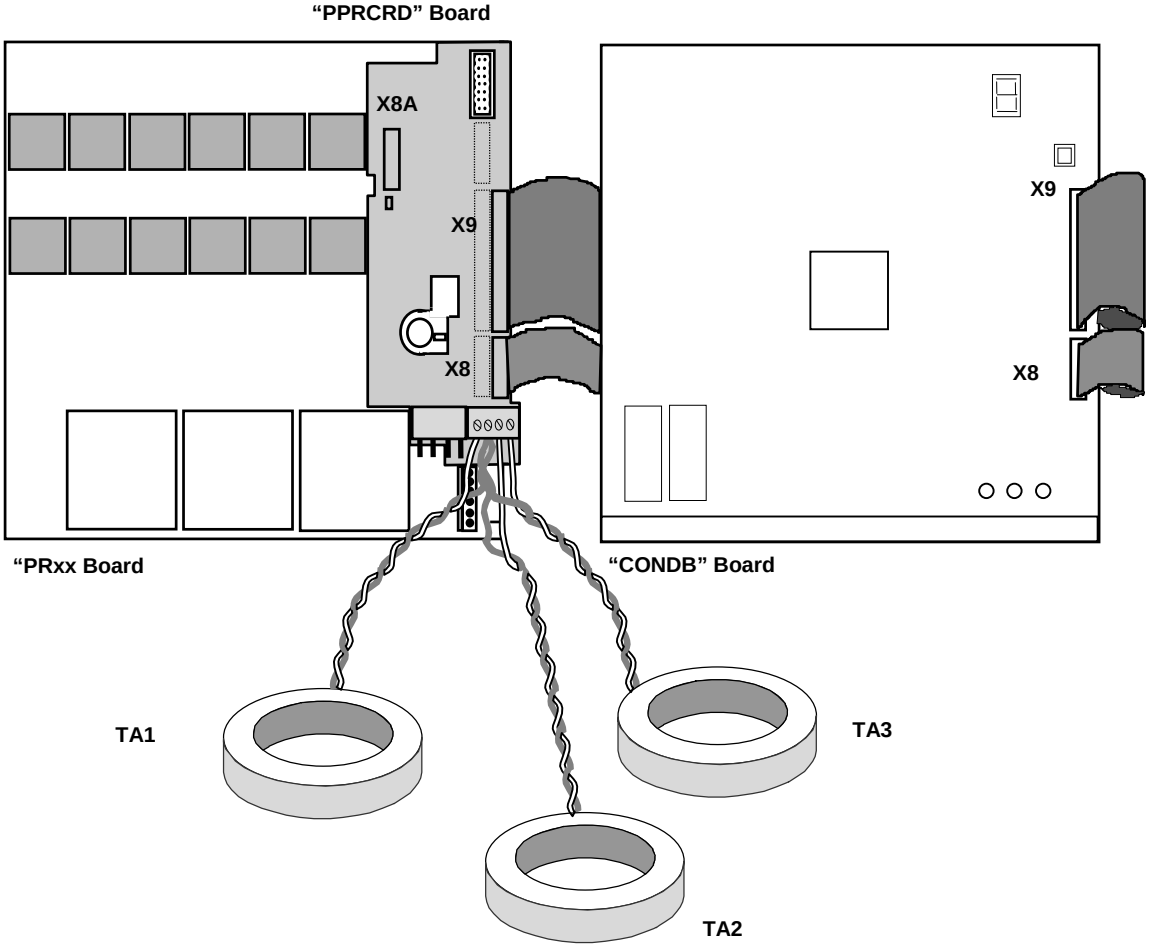


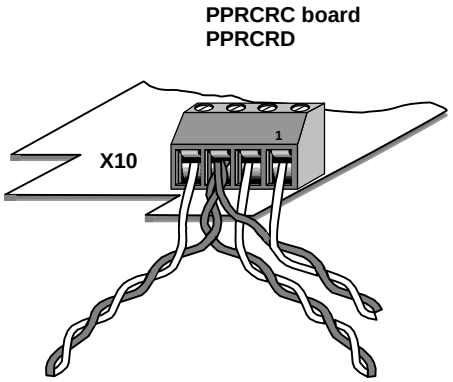


Thermal relay (contact N.C.)

X10 connector of P board is used to connect the thermal sensor only (NC contact).

Between the control board (“CONDB”) and the power board (“PRxx”) is placed a board (“PPRCRC/D”) for connection of three current transducers (CT).





APPENDIX H PARALLEL 12-PULSE

Introduction

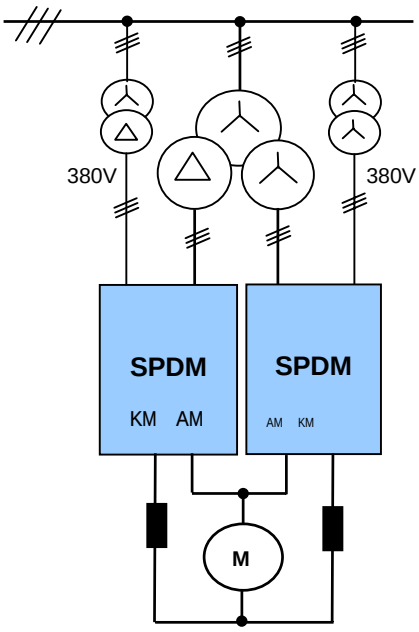
The 12-pulse parallel connection produces the following advantages:

- Reduction in power converter's effects on the mains supply network: reduced harmonics and voltage distorsion
- Large output DC currents: doubling of the output currents die to parallel connection of two 6-pulse standard power converters to form a 12-pulse circuit
- Improved current ripple: smaller current ripple, higher frequency content, smaller torque pulsation

Order of harmonics	Harmonic current as apercentage of Line (RMS)			
	2 pulse	3 pulse	6 pulse	12 pulse
2		46		
3	22			
4		7		
5	13	8	24	
7	8	4	9	
11	4	4	9	4.5
13	4	3	5	3.0

Note. In practice there are some other harmonic currents, due principally to the dissymmetry in the network upstream the non-linear load loads and to the tracking errors of the pulses of thyristor gates. The non-characteristic harmonics have values lower than characteristic harmonics, so they can be ignored.

The 12-pulse parallel connection is a classical master-slave configuration with a speed controlled 6-pulse master converter and a current controlled 6-pulse slave converter.
Feeding the slave with a mains supply offset by 30 degrees compared to the master and joining the power converter outputs on one side over an interphase reactor obtain the 12-pulse parallel connection.
The benefit with this arrangement is that in the supply side some of the harmonics are in opposite phase and thus eliminated. In theory the harmonic component with the lowest frequency seen at the primary of the transformer is the 11th.
The Twelve-Pulses solution is usually used in the applications for the cable transport (cableways, ski-lifts, teleferages, etc.), but also when its peculiar characteristics are needed.
After a few parameters have been set, the two power converters will work in the usual way.
The Parallel Dodecaphase control for SPDM is obtained in the following way:
The connection between the Master Drive and the Slave Drive is made by means of the analog inputs and outputs.
The Master Drive sends through an analog output PWM the current reference either to the Master Drive or to the Slave Drive.
The signals are acquired from one analog input Ean previously configured.



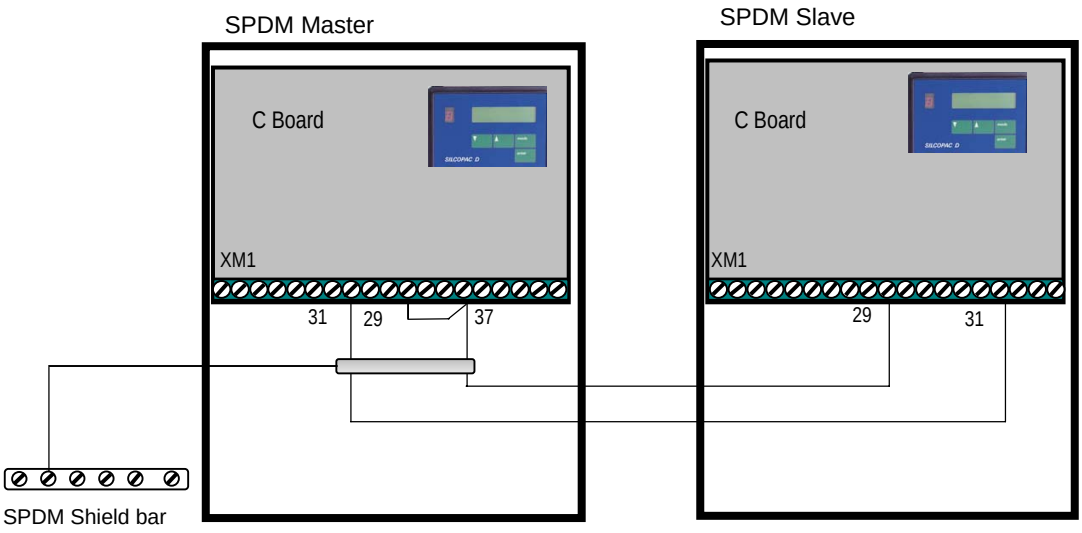
Components

The following components are required for constructing a 12-pulse system:
- a transformer with two identical secondary windings offset by 30 degrees (same voltage and current)
  For suppressing capacitive cross-talk at switching operations on the primary side, the transformer should have an earthed shielding winding between the primary and secondary windings. However, to avoid over-voltages is advisable to provide the secondary sides with a voltage clamp. In addition, the shielding winding also suppresses conducted interference (EMC) to the mains.
- two identical 6-pulse power converters (SPDM standard), selected for half the motor's rated current (same voltage and current)
- a current-balancing reactor (interphase reactor)
  The 12-pulse interphase reactor limits the cross current between the two power sections of the 6-pulse power converters
- a field supply unit for supplying the field of the DC machine

Connections

Both drives must be installed according to the modalities described in chapter 7A, and each must be connected to its secondary of the power transformer (it is necessary to follow the correct phase sequence so that the two drives are synchronized according to the same cyclic direction). The TA charge resistors and the recalibration of the armature current must be calculated so as to obtain, for each of the two drives, a max current Ia_M (hexaphase) corresponding to the half of the max rated current of the motor (dodecaphase).

The Master drive sends also to the Slave drive the current reference through the analog output Pwm1. It is necessary to connect the output PWM1 of the Master drive to the two analog inputs Ean1 either of the Master Drive or the Slave drive and the analog 0V of the Master drive to the analog 0V of the Slave drive only.



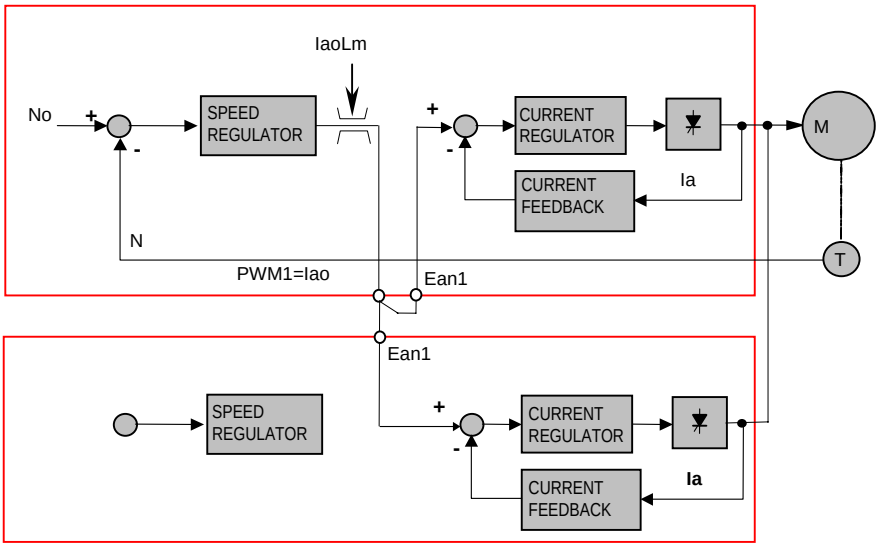
Programming

All the first programming phase, apart from the regulator calibration, can be performed for both converters (considered one by one) according to the standard modalities described in chapter 8.
The programming can be made through interface to a personal computer or by using the user interface SPDI1 or SPDI2.

Master converter programming

PWM1 output meaning selection: DM1
(armature current reference)

Armature current reference origin:
CA1 IaoSl Ean1
(from analog input Ean1)
(terminal XM1-29).



Slave converter programming
Armature current reference origin:
CA1 IaoSl Ean1
(from analog input Ean1)
(terminal XM1-29).

Checks

The offsets of the analog inputs must be properly set to zero through the parameters DH3 and that the full-scales are correctly calibrated.
Drives (Master and Slave) in suppression (H - 1).
Program with the value Iao (value = 0) the parameter DM1 of Master converter.
by using the function Hardware Status verify the reading (%) on the analog input Ean1 of both drives; if the reading is different from zero, compensate the offset by programming with the correct value the parameter DH3 (for both drives).
Program with the value +100% the parameter DM4 of Master converters;
by using the function Hardware Status verify the reading (%) on the analog input Ean1 of both drives; if the reading is different from +100%, regauge the inputs and program with the correct value the parameters DJ3 (for both drives).

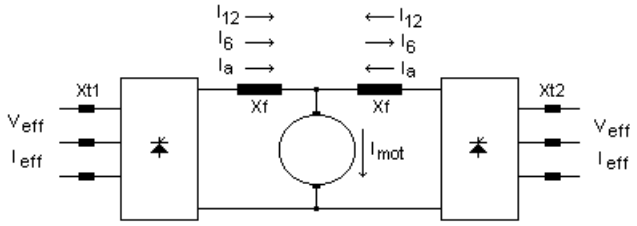
Calibration of current regulator

Carry out the calibration of TA1 and TA2 by operating only on the Master converter and keeping the rotor locked with Slave converter disabled.

Copy the values of TA1 and TA2 on the Slave converter.

With rotor locked, by using the function Setup Reference (paragraph C1.3.7) only on the Master, enable both the drives, set a current reference and check the stability of the current. Repeat the same test for different values of current reference and, if necessary, refine the calibration of the current regulator by operating on the parameters TA1 and TA2 on both the drives.

CALCULATION OF THE INTER-PHASE REACTORS-DODECAPHASE DRIVE



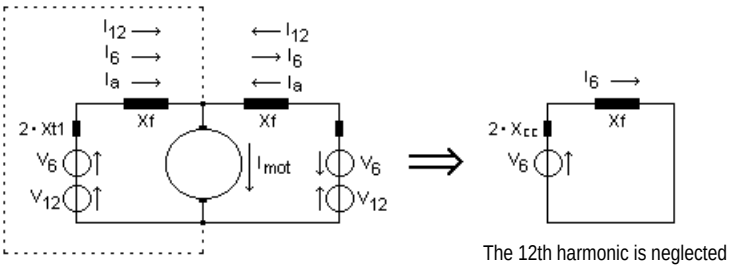
V_{eff} effective value of the line voltage
I_{eff} effective value of the line current
I_{mot} armature current of the motor
I_a current of a converter = Imot / 2
I_6 effective value of the sixth harmonic of the current Ia
I_{12} effective value of the twelveth harmonic of the current Ia
V_6 effective value of the sixth harmonic of the rectified voltage
X_{t1} shortcircuit reactance first secondary side
X_{t2} shortcircuit reactance second secondary side

Normally $X_{t1} = X_{t2} = X_{cc}$

$$X_{cc} = \frac{X_{cc}\%}{100} \cdot \frac{V_{eff}/\sqrt{3}}{\sqrt{\frac{2}{3}} \cdot I_a} = \sqrt{2} \cdot \frac{X_{cc}\%}{100} \cdot \frac{V_{eff}}{I_{mot}} \qquad (1)$$

Circuit equivalent to the effects of the harmonics

The circuit sourrounded by the short dashes line, drawn in a simpler way on the right, is to be taken into account in order to calculate the inter-phase reactors X_f .



The 12th harmonic is neglected

The reactor X_f must limit the sixth harmonic current:

$$I_6 \leq 0.2 \cdot I_a$$

$$V_6 = 0.24 \cdot Vdo = 0.24 \cdot \frac{3}{\pi}\sqrt{2}\ V_{eff}$$

where X_t is the total reactance at the line frequency.

$$I_6 = \frac{V_6}{6\,X_t} \longrightarrow X_t = \frac{V_6}{6\,I_6}$$

From the previous relations the following formula is obtained:

$$X_t = \frac{0.24 \cdot \frac{3}{\pi}\sqrt{2}\ V_{eff}}{6 \cdot 0.2 \cdot \frac{I_{mot}}{2}} = 0.54\ \frac{V_{eff}}{I_{mot}} \qquad (2)$$

Total reactance (at line frequency) $X_t = X_f + 2X_{cc} \rightarrow X_f = X_f - 2X_{cc}$

From (1) and (2) the following formula is obtained:

$$X_t = (0{,}54 - \sqrt{8}\frac{X_{cc}\%}{100}) * \frac{V_{eff}}{I_{mot}}$$

Inductance of the inter-phase reactor:

$$L_f = \frac{X_f}{2\pi f} \cdot 10^6 \quad (\text{microHenry})$$

MONTEBELLO VICENTINO - ITALY

DECLARATION OF "CE" CONFORMITY

CE / 07

Issued according to the "H Form" (complete Quality Assurance) of the CE conformity evaluation procedure (Directive 93/465/EC)

Manufacturer:	***Answer Drives S.r.l.***
Manufacturer's Address:	**Head Office: Viale Sarca, 336 – 20126 Milano – Italy** **Operation Site S.S. 11 – Cà Sordis, 4 - 36054 Montebello Vicentino (VI) – Italy**

DECLARES, on its own exclusive responsibility, that the products:

Product	**Product Family Silcopac D (SPDM)**
Product Description:	***AC/DC Converters with currents from 30 A to 4000 A***

according to the verifications performed, comply with the requirements of the:

European Community Directive 2006/95/EC
called "Low Voltage" Directive

The products have been manufactured according to the harmonized Technical Standard:

CENELEC EN 60146-1-1
*edition 1991, corresponding to Standard **CEI 22-7***
CENELEC EN 60146-2
*corresponding to Standard **CEI 22-21***

Moreover, they comply, according to the tests performed, with the requirements of the:

European Community Directive 89/336/EEC
modified by modified 93/68/EEC, called "EMC" Directive

since they comply with the harmonized Technical Standard:

CENELEC EN 61800-3
*corresponding to the Publication **IEC 61800-3** (edition 2005) and to the Standard **CEI 22-10***

provided that they are installed according to the instructions contained in the use and installation manual, in the machine diagrams and in the documents eventually drawn concerning electromagnetic compatibility. In determining the acceptation limits the installation environment, as well as the distribution and circulation modes of the products have to be taken into consideration. Moreover, it is herewith declared that the products have been manufactured workmanlike according to the instructions/warnings communicated by the suppliers of the components.

ADDITIONAL INFORMATION

To allow their installation on a machine, the products are coordinated with the applicable requirements of the harmonized Technical Standard:

CENELEC EN 60204-1
*corresponding to the Publication **IEC 60204-1** (edition 1997) and to the Standard **CEI 44-5***

Answer Drives S.r.l.
The Director
Ambrogio Boselli

Montebello Vicentino, 2007, September 30

MONTEBELLO VICENTINO - ITALY

DECLARATION OF INCORPORATION

According to Machinery Directive 98/37/EC

Declaration drawn according to Enclosure B of Directive 98/37/EC (former 89/392/EEC)

Manufacturer:	***Answer Drives S.r.l.***
Manufacturer's Address:	**Head Office: Viale Sarca, 336 – 20126 Milano – Italy** **Operation Site S.S. 11 – Cà Sordis, 4 - 36054 Montebello Vicentino (VI) – Italy**

DECLARES, on its own exclusive responsibility, that the products:

Product	**Product Family Silcopac D (SPDM)**
Product Description:	***AC/DC Converters with currents from 30 A to 4000 A***

have to be installed according to our installation manuals and cannot be operated until the machine, in which they are incorporated and within which they are considered to be components, has been declared complying with the "**Machinery Directive 98/37/EC**".

Answer Drives S.r.l.
The Director
Ambrogio Boselli

Montebello Vicentino, 2007, September 30



Answer Drives S.r.l.
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